Residential, Commercial, and Industrial Technical Work Group
Policy Option Descriptions
For May 3, 2006 TWG Meeting

NOTES:

Document format: This revised format for policy descriptions and results is consistent with forms used at the most recent CCAG meeting, and will be used for (appendices to) the draft final report.

Yellow highlights: These indicate comments or changes to the policy designs made during the most recent CCAG meeting.

Policy overlaps: Note that there may be some double counting of savings among several of the measures analyzed here. For example, energy savings at state buildings (RCI-2) may result from (and thus be counted within) overall energy efficiency program efforts (RCI-1) or beyond code building standards (RCI-5). There is no simple way to adjust estimates can be adjusted to account for this effect, without very detailed analysis. In other studies of this nature, overlaps and double counting have either been considered insignificant in overall context or they have been accounted for using simple discount factors (e.g. including all of the savings from efficiency programs, such as in RCI-1, and then deducting half of the savings from overlapping measures, such as appliance standards, in RCI-3). The former approach may tend to overstate emission reductions, while the latter approach may tend to understate them.

Please review the analyses closely. Please provide any detailed feedback by email, in addition to raising general points during the upcoming call.

Thanks again for all of your input to this effort.

Table 5.

Residential Commercial and Industrial Technical Work Group

Summary List of Draft Policy Options (12 Total)

#	Policy Name	GHG Savings ($MMtCO_2e$)	Cost-Effectiveness ($\$/tCO_2e$)	Status
	RESIDENTIAL, COMMERCIAL, AND INDUSTRIAL			
RCI-1	Demand-Side Efficiency Goals, Funds, Incentives, and Programs	2010: 3.2 2020: 15.3	- $36	Preliminary Quantification Completed for TWG review
RCI-2	State Leadership Programs	2010: 0.04 2020: 0.3	- $4	Preliminary Quantification Completed for TWG review
RCI-3	Appliance Standards	2010: 0.2 2020: 1.0	- $66	Preliminary Quantification Completed for TWG review
RCI-4	Building Standards/Codes for Smart Growth	2010: 0.2 2020: 1.8	- $18	Preliminary Quantification Completed for TWG review
RCI-5	"Beyond Code" Building Design Incentives and Programs for Smart Growth	2010: 0.2 2020: 2.7	- $18	Preliminary Quantification Completed for TWG review
RCI-6	Distributed Generation/Combined Heat and Power	2010: 0.4 2020: 2.7	- $25	Preliminary Quantification Completed for TWG review
RCI-7	Distributed Generation/Renewable Energy Applications	2010: 0.1 2020: 2.1	$31	Preliminary Quantification Completed for TWG review
RCI-8	Electricity Pricing Strategies			Draft Recommendation without Quantification
RCI-9	Mitigating High Global Warming Potential (GWP) Gas Emissions (HFC, PFC)			Draft Recommendation without Quantification
RCI-10	Demand-Side Fuel Switching	2010: 0.1 2020: 1.2	*Not Yet Estimated*	Preliminary Quantification Completed for TWG review
RCI-11	Industrial Sector GHG Emissions Trading or Commitments			Draft Recommendation without Quantification
RCI-12	Solid Waste, Wastewater, and Water Use Management			Straw Proposal and Quantification in Process

Table 6.

Description of Draft Residential Commercial and Industrial Policy Options

RESIDENTIAL, COMMERCIAL, AND INDUSTRIAL

RCI-1 Demand-Side Efficiency Goals, Funds, Incentives, and Programs

Option Category: Quantified.

Description: This policy option considers energy savings goals for electricity and natural gas, and the policy, program, and funding mechanisms that might be used to achieve these goals. These are intended to work in tandem with other strategies under consideration by the RCI and ES TWGs.

Design: This option contains the following three principal elements, along with several supporting activities:

Goals: Suggested energy savings goals are as follows:

- Electricity (energy savings target): 5% savings by 2010, 15% savings by 2020. These savings targets would be for electricity sales (MWh), and would reflect cumulative (from today), verified savings as a percentage of those years' (projected) loads, starting from the time of policy adoption.
- Natural Gas (utility spending target): ramp up to spending 1.5% of revenues by 2010.[1] (Note that this would represent a doubling of Southwest Gas' DSM funding, from a level of 0.8%, which is expected to be approved shortly. With further decisions to decouple gas sales and revenues, a higher target might be possible. On the other hand, without decoupling, a 1.5% target may be too ambitious.) *[It was noted that while SW gas DSM funding was recently approved, decoupling was not.]*

[CCAG members expressed a desire to ensure that these targets are adequately ambitious, and thus to revisit these targets once initial analysis is complete.]

Funding and Implementation Mechanisms: Several policy options are commonly used to overcome market, administrative, and institutional barriers to cost-effective efficiency improvements. These options can include public benefit charges, tariff riders, enabling

[1] Electricity and natural gas goals are deliberately expressed in different metrics -- energy savings and revenue targets, respectively – due to recognized differences in experience with efficiency programs with each fuel. Experience with electricity efficiency is sufficient to enable targets to be established, as has been done in several states (e.g. CA and TX). Experience with natural gas efficiency programs is more limited, thus it may be premature to establish energy savings goals.

legislation, and/or regulatory directives. They can also work together with state and national tax incentives for energy efficient equipment. Specific funding and implementation mechanisms will be determined pursuant to the analysis of the energy savings goals above.

Incorporation of Efficiency in a Planning Context: Inclusion of energy efficiency resource in an integrated resource planning (IRP) process can enable the overall most efficient and cost-effective delivery of energy services. IRP is currently practiced in Arizona, and is under consideration by the ES TWG.

In addition, supporting activities may be important elements in the success of energy efficiency strategies. These supporting strategies could include consumer education and outreach programs (including, for example, enhanced State Energy Office and University-based energy-efficiency extension services), and market transformation programs and organizations. Supporting strategies will be considered as part of overall recommendations, but their impacts will not be quantified. They could also include decoupling utility sales and revenues and creating performance incentives that reward utilities for implementing effective DSM programs.

Implementation method(s): TBD

Related Policies/Programs in place:

- Arizona utilities (including APS, SRP, TEP and Southwest Gas) operate a number of DSM programs, including audits, new home programs, shade tree programs, appliance rebates, and others. In addition, the Arizona Department of Commerce's Energy Office provides energy efficiency programs for businesses, communities and homeowners in Arizona.
- In 2004, the Arizona Corporation Commission (ACC) issued a recommended order in a recent Arizona Public Service Co. rate case, supporting a funding level of $16 million per year for APS demand-side management (DSM) programs, an increase from $1 million per year.
- In 2002, Tucson Electric Power was approved to spend $1 million of System Benefits Charge funding for low income and energy efficiency programs
- Arizona home sellers can subtract five percent (up to $5,000) of the sales price of a single family home or condominium that is 50% more efficient than the 1995 Model Energy Code (MEC) from their income for the purpose of calculating their state income tax. The income tax deduction is available through 2010.

Types(s) of GHG Benefit(s):
Principally, the reduction in GHG emissions (largely CO_2) from avoided electricity production and avoided on-site fuel combustion. Less significant are the reduction in CH_4 emissions from avoided fuel combustion and avoided pipeline leakage. Other GHG impacts are also conceivable, but are likely to be small (black carbon, N2O) and/or very difficult to estimate (materials use, life cycle, market leakage, etc.).

Estimated GHG Savings and Costs per Ton:

Combined results for RCI-1 (elec.and natural gas)	2010	2020	Units
Recent Actions not included in forecast (current/planned efficiency spending levels)			
GHG Emission Savings	**0.4**	**1.3**	MMtCO2e
Impact of Additional Effort in RCI-1			
GHG Emission Savings	**3.2**	**15.3**	MMtCO2e
Net Present Value (2006-2020)		**-$3,816**	$million
Cumulative Emissions Reductions (2006-2020)		105	MMtCO2e
Cost-Effectiveness		**-$36**	$/tCO2e
Other Key Results			
Fraction of Electric Utility Revenues spent on efficiency	**2.6%**	**2.5%**	
Equivalent Public Benefit Charge (electricity)	**1.9**	**1.8**	$/MWh
GHG Emission Savings (RCI-1) from Electricity	3.1	14.9	MMtCO2e
GHG Emission Savings (RCI-1) from Natural Gas	0.1	0.4	MMtCO2e
Electricity Savings Goals (including recent actions)	4,208	18,400	GWh (sales)
Natural Gas Savings Goals (including recent actions)	2,828	14,625	Billion BTU

Discussion: Savings from recent actions reflects the emissions reductions that are likely to accrue from current and planned statewide spending levels on energy efficiency ($12 million/year for electricity; 0.8% of SW Gas natural gas revenues for natural gas). The impact of additional effort in RCI-1 reflects the added statewide economic savings (nearly $4 billion, NPV through 2020) and emissions reductions that would accrue from the statewide goals in this policy measure over and above the current and planned statewide spending levels. The negative cost-effectiveness and NPV reflect a *net benefit* statewide.

The fraction of electric utility revenues spent on efficiency averages about 2.5%. This level of spending is similar to that maintained by utilities in the Pacific Northwest in the 1990s. If this level of spending were translated into a public benefit charge, it would require a public benefit charge on the order of about $2/MWh (0.2 cents or 2 mills per kWh). *[Note that the ES group is discussing a public benefit charge for efficiency and renewables of about 4 mills per kWh.]*

Data Sources, Methods and Assumptions: See the attachment at the end of this document for a more detailed listing of methods, data sources, and assumptions. In summary:

- **Data Sources:** Key data sources include USDOE Energy Information Agency (historical and projected prices, SW Gas market share), WGA CDEAC EE Task Force, Northwest Power Council, and California Energy Commission (costs of efficiency programs), SW Energy Efficiency Project (current level of electricity efficiency spending.)
- **Quantification Methods:** The estimation of electricity and natural gas savings (MWh and Mbtu) is relatively straightforward. For electricity, savings are simply the goal times that years' projected loads. For natural gas, projected gas revenues are estimated (based on projected prices and sales), then multiplied by the goal (1.5%) and by the assumed savings per program dollar spent (below). GHG savings are estimated based on marginal emissions

rates for electricity (0.7 to 0.8 tCO_2e/MWh – see attachment) and on standard emission rates for natural gas (see inventory). Cost analysis is based on the differential between avoided costs and the levelized cost of efficiency savings.

- **Key Assumptions:** Key assumptions include avoided electricity and gas costs (levelized prices used as a proxy), levelized total costs of efficiency programs ($25/MWh, $2.1/MMBtu), and program spending requirements (6 MWh/yr per $1000 spent, 75 MMBtu/yr per $1000 spent). Another key assumption is that the savings goals apply to all electric and gas utilities in the state.

Key Uncertainties:

- Avoided electricity and natural gas costs.
- Costs and availability of efficiency resources.

Ancillary Benefits and Costs: These include (WGA CDEAC, 2005)

- saving consumers and businesses money on their energy bills;
- reducing dependence on imported fuel sources;
- reducing vulnerability to energy price spikes;
- reducing peak demand and improving the utilization of the electricity system;
- reducing the risk of power shortages;
- supporting local businesses and stimulating economic development;
- enabling avoidance of the most controversial energy supply projects;
- reducing water consumption by power plants; and
- reducing non-GHG pollutant emissions by power plants and improving public health.

Feasibility Issues, if applicable:

Status of Group Approval: (Pending or Completed)

Level of Group Support: (Unanimous Consent, Supermajority, Majority, or Minority)

Barriers to consensus (if less than unanimous consent):

RCI-2 State Leadership Programs

Option Category: Quantified.

Description: 'Lead by Example' initiatives help state and local governments achieve substantial energy cost savings while promoting the adoption of clean energy technologies by the public and private sectors.

Design: The policy action under consideration would include:

- Extension of state building energy savings goals (Statute A.R.S. 34-45) to include a further 15% reduction in energy use per square foot in state buildings from 2011 to 2020, along with purchasing of EnergyStar equipment.

- Standards for new state buildings, with possible design parameters including recommendations for new buildings to be [X%] better than code or LEED-related requirements, such as those recommended by the Arizona Working Group on Renewable Energy and Energy Efficiency and by the WGA CDEAC EE[2] Task Force (See also Option RCI-5), as well as mechanisms to support the state in achieving its goals.
- Green Procurement Strategies, such as installation of renewable energy systems as additional backup services in emergency services buildings, and efforts to promote or require the purchase by state buildings of 5% of their building energy needs from renewable sources (over a phased-in period) by 2012.
- The promotion of new combined heat and power (CHP) facilities in State Buildings, such as the facilities in place and under construction at Arizona State University and the University of Arizona (approximately 25 MW total), and the expansion of existing performance contracting law to require life cycle analysis for CHP in State lease-purchase construction.

The TWG suggests that the State Energy Office add staff capability and responsibility for a) ensuring effective compliance with state procurement and savings goals, and b) sharing and communicating the state's accomplishments and lessons learned (a "cooperative extension" role). Furthermore, the state should consider adopting procurement guidance (such as that included in the recent federal energy bill).

[CCAG members suggested revisiting the green purchase target to ensure that it is adequately ambitious, and to ensure that the state leadership targets, in general, could not be circumvented through outsourcing (that is, that the targets be applicable to private entities working as contractors to the State). The more complete policy description includes a number of additional components including the state ombudsman role noted during the CCAG meeting.]

Implementation method(s): These could include, among others, funding mechanisms and incentives, legislation/statutes, codes and standards, and reporting.

Related Policies/Programs in place:

- Statute A.R.S. 34-451 directs state agencies and universities to achieve a 10% reduction in energy use per unit of floor area by 2008, and a 15% reduction by 2011; purchase cost-effective ENERGY STAR or Federal Energy Management Program-designated energy-efficient products; and meet energy conservation standards developed by the Arizona Department of Commerce's Energy Office.
- HB 2501 "Schools: Energy Efficiency Funds", if adopted, will promote the establishment of energy efficiency funds by schools, with monies deposited by utilities. The funds will be used to purchase energy-efficiency products and services. Schools use utility bill

[2] Energy Efficiency Task Force Report to the Clean and Diversified Energy Advisory Committee of the Western Governors' Association

savings to repay the capital cost of energy efficiency measures (see http://www.azleg.state.az.us/FormatDocument.asp?inDoc=/legtext/47leg/2r/summary/h.hb2501_02-15-06_caucuscow.doc.htm).

- Executive Order 2005-05 implementing renewable energy and energy efficiency in new state buildings (http://www.governor.state.az.us/eo/2005_05.pdf)
- A May 2001 Executive Order directed state agencies and employees to implement energy conservation measures in state facilities.

Types(s) of GHG Benefit(s): To the extent state actions are focused on reducing electricity and natural gas purchases or increasing renewable energy production, GHG impacts are likely to be similar to those described for RCI1 above.

Estimated GHG Savings and Costs per Ton:

Summary Results for RCI-2	2010	2020	Units
Savings from Recent Actions not included in forecast (current state building savings goals)			
GHG Emission Savings	**0.16**	**0.28**	MMtCO2e
Impact of RCI-2 Policies			
GHG Emission Savings	**0.04**	**0.31**	MMtCO2e
Net Present Value (2006-2020)		**-$14**	$million
Cumulative Emissions Reductions (2006-2020)		3	MMtCO2e
Cost-Effectiveness		**-$4**	$/tCO2e
Other Key Results			
Green Power Purchased	45	92	GWh (sales)
GHG Emission Savings from Green Power Purchasing	**0.04**	**0.08**	MMtCO2e
GHG Emission Savings from Extending Building Savings Goals	**0.00**	**0.23**	MMtCO2e

- **Discussion of Results:** Two elements of this policy option are readily quantifiable: extending and deepening the state building energy savings goals from 2011 onward, and green power purchasing. The benefits of promoting CHP at state buildings is incorporated in the overall assessment of commercial CHP potential (see policy RCI-6), and is not reported separately here. Similarly, the benefits of standards for new state buildings is not estimated separately here, but is incorporated in the analysis of new building strategies below (see policies RCI-4 and RCI-5).

  The negative cost-effectiveness and NPV reflect an overall net benefit statewide. The cost savings of the extended state buildings goals ($18 million, NPV) more than offsets the net costs of the green power purchasing efforts ($5 million, NPV).

Data Sources, Methods and Assumptions: See the attachment at the end of this document for a more detailed listing of methods, data sources, and assumptions. In summary:

- **Data Sources:** The Arizona Department of Commerce (Jim Westberg, Energy Program

Administrator) provided estimates of state building energy consumption. The cost of state building efficiency efforts ($47/MWh) is based on the review of relevant literature summarized in the WGA CDEAC Energy Efficiency Task Force report. The incremental cost of green power ($9/MWh) is based on current bulk programs (e.g., Pacificorp's BlueSky program).

- **Quantification Methods:** Emissions savings and costs are calculated in a straightforward manner analogous to RCI-1.
- **Key Assumptions:** State building square footage is assumed to grow at the rate of commercial GSP growth assumed used in the emission forecast (4.9%/year).

Key Uncertainties:

- Avoided electricity and natural gas costs.
- Costs and availability of efficiency resources.
- Incremental costs of green power.
- Rate of growth in state building area.
- Ability to track and enforce building efficiency and green purchasing goals.

Ancillary Benefits and Costs: Ancillary impacts are similar to those described for RCI1 above.

Feasibility Issues, if applicable:

Status of Group Approval: **(**Pending or Completed)

Level of Group Support: (Unanimous Consent, Supermajority, Majority, or Minority)

Barriers to consensus (if less than unanimous consent):

Additional Material Discussed by TWG, but not discussed at last CCAG meeting:
[TWG members should reflect on priority items to incorporate in the policy design above]

- With respect to the LEED green building standards, the State should investigate the feasibility of requiring additional commissioning and measurement & verification efforts to ensure that they are meeting energy targets."
- "Construct new buildings that are exemplary and surpass minimum energy code requirements by a wide margin." (WGA CDEAC EE Task Force)

Supporting Activities and Mechanisms: The TWG suggests that the State Energy Office add staff capability and responsibility for a) ensuring effective compliance with state procurement and savings goals, and b) sharing and communicating the state's accomplishments and lessons learned (a "cooperative extension" role). Furthermore, the state should consider adopting procurement guidance (such as that included in the recent federal energy bill). Additional recommendations could include:

- The Governor should use public events, such as installing energy efficiency products in the Governor's residence, or openings of new energy efficient projects, or public awards (energy efficiency or renewable energy awards) to draw attention to the State's renewable

energy and energy efficiency ethic. (AZ EE/RE Working Group)
- The Governor and state agencies should promote the use of State and other public facilities as demonstrations of energy efficiency and renewable energy. (AZ EE/RE Working Group)
- Provide financial and technical assistance for implementation of energy savings projects in existing buildings and facilities. (WGA CDEAC EE Task Force)
- Use energy service companies (ESCOs) and performance contracting to implement efficiency projects without public sector capital investment. (WGA CDEAC EE Task Force)

Green Procurement Strategies: These could include various initiatives, including for instance, the following recommendations of the AZ Working Group:

- The Governor and the Department of Administration should establish a program to install renewable energy systems as additional backup services in emergency services buildings (police stations, fire stations, National Guard facilities).
- The Governor should require state buildings – including schools – to purchase, install and operate cost-effective renewable energy equipment or purchase green power to meet 5% of their building energy needs over a phased-in period by 2012.
- The Governor and State agencies should require State offices to buy a percentage of their electricity from renewable resources, if cost-effective.

Promoting CHP (cogeneration) in State Buildings:
- Current law (ARS 34-355) allows the use of cogeneration (combined heat and power) in performance contracting. This law should be expanded to require life cycle analysis for CHP in State lease-purchase construction.
- HB 2430 expands the use of CHP for State facilities and schools. This law (if ultimately adopted) should be built upon in the future (see http://www.azleg.state.az.us/FormatDocument.asp?inDoc=/legtext/47leg/2r/summary/h.hb2430_02-24-06_asengrossedandaspassedhouse.doc.htm

RCI-3 Appliance Standards

Option Category: Quantified.

Description: Implementation of State appliance efficiency standards for appliances not covered by federal standards or where higher-than-federal standard efficiency requirements are appropriate.

Design: Appliance efficiency standards reduce the market cost of energy efficiency improvements by incorporating technological advances into base appliance models, thereby creating economies of scale. Appliance efficiency standards can be implemented at the state level for appliances not covered by federal standards. Arizona, along with several other states, recently adopted state level appliance efficiency standards covering several appliances. State actions led the Federal government to adopt rule making for these appliances in the 2005 energy bill. California has established standards for a number of appliances not covered by Arizona or national legislation, such as pool pumps, consumer electronics (stand-by power use), and general-service incandescent lamps.

The specific policy approach suggested by the TWG is to:

- First, advocate for stronger federal appliance efficiency standards where this is technically feasible and economically justified.
- Second, for those appliances not likely to be covered by federal efforts, pursue efficiency standards already adopted by California and/or other states.
- Where possible, consider encouraging local manufacturing of high-efficiency appliances and equipment when adopting state standards.

[A CCAG member suggests the consideration of efficiency standards for biomass stoves, solar water heaters, and other renewable energy technologies, as well as for other thermal appliances where efficiency standards do not exist or are inadequate.]

Implementation method(s): Codes and Standards

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Related Policies/Programs in place:

- Arizona Appliance Efficiency Standards [HB2390]
- Existing Federal Appliance Efficiency Standards [2005 Energy Bill]

Types(s) of GHG Benefit(s): Similar to RCI-1.

Estimated GHG Savings and Costs per Ton:

Summary Results for RCI-3	2010	2020	Units
Total for Policy (Natural gas and electricity)			
GHG Emission Savings	**0.24**	**0.96**	MMtCO2e
Net Present Value (2006-2020)		**-$453**	$million
Cumulative Emissions Reductions (2006-2020)		7	MMtCO2e
Cost-Effectiveness		**-$66**	$/tCO2e

Data Sources, Methods and Assumptions: See the attachment at the end of this document for a more detailed listing of methods, data sources, and assumptions. In summary:

- **Data Sources:** The results are drawn from a recent report by the Appliance Standards Assistance Project and the American Council for an Energy Efficiency Economy.[3]
- **Quantification Methods:** The ASAP/ACEEE report uses estimates of appliance sales by states along standard incremental cost and savings analysis to develop state-specific results

[3] ASAP and ACEEE, 2006. "Leading the Way: Continued Opportunities for New State Appliance and Equipment Efficiency Standards", http://www.standardsasap.org/stateops.htm .

for 15 specific appliances.[4] The study's NPV results were derived using the same discount rate (5%) as in our analysis, but a longer time span (to 2030). For consistency, the NPV savings were reduced (by about 30%) to reflect the shorter time horizon used for cost analysis in the CCAG process (to 2020).

- **Key Assumptions:** The study used prices slightly different than used for the CCAG analyses – they use 9.0c/kWh ($13.52/Mbtu gas) residential and 7.6c/kWh ($9.65/Mbtu gas) commercial. The resulting NPV savings differ slightly from those that would be obtained using our avoided delivered electricity and gas cost estimates.

Key Uncertainties:

- Ability to track and enforce compliance with standards.
- Avoided electricity and natural gas costs.

Ancillary Benefits and Costs: Similar to RCI-1.

Feasibility Issues, if applicable:

Status of Group Approval: **(**Pending or Completed)

Level of Group Support: (Unanimous Consent, Supermajority, Majority, or Minority)

Barriers to consensus (if less than unanimous consent):

RCI-4 Building Standards/Codes for Smart Growth

Option Category: Quantified.

Description: Given the State's growth and the long lifetime of buildings, the current and future building codes will have a considerable impact on future energy use in buildings, and on related greenhouse gas emissions, thus improved and increasingly stringent energy efficiency codes for Arizona are proposed.

Design: Building energy codes specify minimum energy efficiency requirements for new buildings or for existing buildings undergoing a major renovation. *[A CCAG member noted that the threshold for major renovation needs to be defined.]* It is recommended that Arizona take the following actions in order to realize the energy savings and other benefits offered by state-of-the-art building energy codes[5]:

- Arizona should either establish a statewide mandatory code or strongly encourage local

[4] See http://www.standardsasap.org/a062_az.pdf for a table listing the 15 appliances considered, and their costs and savings. The carbon emissions savings shown in this document are not used, instead the marginal electricity emission factors used for other CCAG policies are used.

[5] Many of these suggestions are consistent with recommendations included in the WGA CDEAC EE report (for example, page 59).

jurisdictions to adopt and maintain state-of-the-art codes. Adoption is targeted for 2007, with codes in force in early 2008, but with the recognition that some municipalities in Arizona may implement energy efficiency codes later than others.

- Arizona and/or local jurisdictions should adopt the 2004 International Energy Conservation Code (IECC), to the extent that adoption has not already occurred. Also, Arizona and/or local jurisdictions should consider adopting innovative features of California's latest Title 24 building energy codes, such as lighting efficiency requirements in new homes. In considering the adoption of building code elements, Arizona and/or local jurisdictions should take into account the time-dependent value of energy by, for example, noting the extra benefits from code revisions that are particularly effective in saving on-peak electricity or gas.
- Arizona and local jurisdictions should update energy codes regularly. A three-year cycle could be timed to coincide with release of the national model codes.
- Revised building codes for Arizona as a whole and for local jurisdictions should be prepared with the involvement of local chapters of code organizations to assist in obtaining support for and compliance with the new policies. All buildings will be covered, including manufactured homes, and local building inspectors will enforce compliance with codes. Inspectors need to be properly trained in new elements of the codes.

Implementation method(s):

- Information and education: Would include training and education programs and certification for building planners, builders/contractors, energy managers and operators, local officials, and others in the building industry, including training on building energy performance analysis tools and software. Would also include programs for consumer and elementary/secondary education.
- Training and technical assistance for code enforcement officials, including training and assistance in the use of building energy performance analysis tools and software, and in the review and analysis of the outputs of building energy performance tools.
- Funding mechanisms and or incentives: Utility programs (designed to encourage building energy performance beyond codes) may help to provide financial assistance for training code officials in the application of building energy codes. Increases in permit fees and/or increase in "impact fees" may also be considered to assist with funding of training for code officials.
- Voluntary and or negotiated agreements: Agreements within Metropolitan Area Government councils to collaborate on building energy codes in order to make compliance easier for building contractors and other building trade professionals.
- Codes and standards—In addition to adoption of state and/or local and/or metropolitan area building energy performance codes, Arizona may consider starting a State Building Energy Codes Collaborative process and/or joining a Regional Building Codes Collaborative, as referenced (for example) on pages 65-66 of the WGA CDEAC EE

report.

Related Policies/Programs in place:
Code changes advanced in some localities, beginning in others. Most urban areas have adopted the IECC 2004 codes, and some (notably Tucson) have adopted more stringent codes.

Types(s) of GHG Benefit(s):

- CO_2 reduction from avoided electricity production and avoided on-site fuel combustion.
- Modest reduction in CH_4 emissions from avoided fuel combustion and avoided natural gas pipeline leakage, relatively small reductions in N_2O, Black Carbon emissions from avoided fuel consumption.

Estimated GHG Savings and Costs per Ton:

Summary Results for RCI-4	2010	2020	Units
Total for Policy (Natural gas and electricity)			
GHG Emission Savings	**0.2**	**1.8**	$MMtCO_2e$
Net Present Value (2006-2020)		**-$201**	$million
Cumulative Emissions Reductions (2006-2020)		11.1	$MMtCO_2e$
Cost-Effectiveness		**-$18.14**	$/$tCO_2e$

- **Discussion of Results**: Savings here are relatively modest in part because significant improvements over codes in place in the last few years are expected as a part of the WGA CDEAC EE Reports "Current Activities" case, and the savings reported here are the different between the "Current Activities" case and the more aggressive "Best Practices" case. Savings in emissions related to reduced electricity consumption account for well over 90 percent of the GHG savings from this policy.

Data Sources, Methods and Assumptions (for quantified actions):

- **Data Sources:** Major data sources include the WGA CDEAC EE report, including background materials for that report developed by the Building Code Assistance Project (BCAP), The Southwest Energy Efficiency Project's (SWEEP) Report Increasing Energy Efficiency in New Buildings in the Southwest: Energy Codes and Best Practices, and results from Table 5.8 of the 2002 Energy Consumptions by Manufacturers--Data Tables published by the US Department of Energy's Energy Information Administration.
- **Quantification Methods:** Results from the WGA CDEAC EE analysis at the State level were adjusted to achieve the results above. See Attachment 1 for further details.
- **Key Assumptions:** Level of code improvements assumed same as in the WGA CDEAC EE analysis, though parameters are included to allow adjustments of those assumptions. The cost of electricity savings through building code improvements, beyond "baseline values", was assumed to be 4.7 cents/kWh on a levelized basis (same source). Ratio of gas to electricity

savings as in the SWEEP Report, above.

Key Uncertainties:
Degree to which improved codes in Arizona may be similar to those assumed in the WGA CDEAC EE analysis. Results have not yet been adjusted for the degree to which statewide code adoption will be different in different parts of the state, due to varying weather regimes.

Ancillary Benefits and Costs, if applicable[6]:

- Saving consumers and businesses money on their energy bills
- Potential to also yield water savings
- Comfort/indoor air quality improvements, with related improvements in health and productivity
- Reducing dependence on imported fuel sources, and reducing vulnerability to energy price spikes
- Electricity system benefits: reduced peak demand, reduced capital and operating costs, improved utilization and performance of the electricity system, reduced pollutant emissions from power plants and related public health improvements
- Supporting local businesses and stimulating economic development
- *Low income populations living in buildings covered by the policy will benefit through lower annual energy costs.*

Feasibility Issues, if applicable:

Status of Group Approval: (Pending or Completed)

Level of Group Support: (Unanimous Consent, Supermajority, Majority, or Minority)

Barriers to consensus (if less than unanimous consent):

RCI-5 "Beyond Code" Building Design Incentives and Programs for Smart Growth

Option Category: Quantified.

Description: Building energy performance standards are implemented in State-funded and other (such as local) government buildings, and similar standards are promoted in other buildings, such that new buildings achieve high standards of energy efficiency, and existing buildings are renovated or retrofitted to yield significant energy efficiency improvements.

Design: Implementation of LEED (Leadership in Energy and Environmental Design)

[6] Many of these ancillary benefits are adapted from those listed on page 2 of the WGA CDEAC EE report.

standards/certifications and/or other "green building" certifications and/or measured or modeled building energy performance criteria may be used to specify building energy performance standards[7]. Implementation of white roofs, rooftop gardens, and landscaping (including shade tree programs would also be covered by this policy. In addition to directly influencing energy use in state-funded and government buildings, this policy will help to raise awareness of energy-efficiency improvement methods in building construction and operation, and will help to "drive" such improvements in other market segments. This policy includes:

- A performance standard for State-owned or state-leased buildings to demonstrate the feasibility of not only achieving the minimum code requirements but also exceeding them. This will demonstrate and encourage the use of advanced energy efficiency products and designs, and will also reward the State with the inherent benefits of more efficient buildings. New state-owned or state-leased buildings will be required to use at least 10 percent less energy per square foot of floor space relative to what the same building would have used if designed to just meet existing energy codes. The requirement of 10 percent lower energy use will be reviewed periodically, but is expected to remain in force as long as the level of improvement remains cost-effective.
- A requirement that state-owned or leased facilities use life-cycle costing, including full consideration of future energy costs, in the selection and implementation of building designs and components for both new and renovated space, or for the selection of replacement components. Further, following life cycle cost analysis, require that the most cost-effective design/equipment/component options be chosen.
- Provide financial or tax incentive for non-pubic and non-state public buildings (such as municipal buildings) to improve their energy performance beyond that required by existing codes[8]. Incentives should be provided for building projects (new, renovated, or remodeled space) where energy consumption per unit floor area is at least 10 percent less that would be the case if the project just met existing codes, noting that energy codes will change over time[9]. Incentives should be structured so that projects that produce higher savings per unit floor area relative to just meeting code requirements receive greater incentives.

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[7] Note that it is not the intent of this policy that achieving LEED or other certifications be required in order to receive incentives, so long as a project achieves an adequate level of energy savings.

[8] There are, as of the writing of this Policy Description, a number of ongoing discussions regarding the LEED certification program, other certification programs, and potential performance guidelines for new and renovated buildings, and as a result, it is not yet clear which certifications or performance guidelines might be adopted or suggested for use in this program. Whichever set of certifications/performance guidelines are adopted should provide designers, builders and contractors with a means to advertise that their work meets a high energy-efficiency standard (through a specific labeling or certification), while also assuring that the actual energy performance of the building significantly exceeds the level required by codes.

[9] *A CCAG member noted that even in the absence of a building energy code improvement policy, energy codes will improve over time, and this "baseline" improvement will need to be taken into account in quantifying the benefits and costs of policies to improve building energy efficiency.*

- Provide similar financial or tax incentives to encourage retrofits of existing buildings to levels of energy efficiency exceeding those required by existing energy codes.
- Performance standards, life cycle costing requirements, and incentive programs to begin in year *20xx*.

Implementation method(s):

- Information and education: Would include training and education programs and certification for state officials, building planners, builders/contractors, energy managers and operators, and local officials on certification that buildings and building subsystems have met program requirements. Would also include programs for consumer and elementary/secondary education.
- Technical assistance: Assistance to building planners, engineers, and others in energy-efficient design and in building energy efficiency analysis, possibly including reference materials, performance/design guidelines, and assistance with energy performance analysis software.
- Funding mechanisms and or incentives: Tax credits and/or incentives related to the rate of amortization of expenses related to buildings or renovation. State grants to help cover additional costs of energy performance enhancements for municipal government buildings.
- Voluntary and or negotiated agreements: Agreements by municipal governments, builders to meet higher energy performance standards in exchange for special certification and/or financial incentives.
- Codes and standards: For state-owned or state-leased space, requirements to exceed codes in force as noted above.
- Pilots and demos: Applications of building energy performance improvements (possibly including demonstration of construction of buildings to LEED or other relevant standards) and urban landscaping for government buildings.

Related Policies/Programs in place:
[NOTE THAT MANY OF THE STATE PROGRAMS LISTED BELOW ARE EITHER VERY RECENTLY ENACTED OR CURRENTLY UNDER CONSIDERATION, AND THUS MAY EFFECTIVELY CONSTITUTE "NEW" STATE GHG POLICIES RATHER THAN "BAU" POLICIES]:

- Related notes in early version of RCI TWG Policy Matrix: "Executive Order 2005-05 implementing renewable energy and energy efficiency in new state buildings; Solar Design Standards for State Buildings; Tucson-Pima Sustainable Energy Program; City of Scottsdale Green Building program"
- Notes in early version of RCI TWG Policy Matrix related to professional education/certification: APS and state Energy Office offer building science training; APS subsidizes contractor training; Energy office provides training [in building codes]; •

Technical assistance from Rebuild Arizona and Arizona Energy Office [for energy management/building operator training]

- Newly-adopted Federal Energy Credit for houses "that reduce energy use for heating and cooling only (not hot water) by 50% compared to the national model code — the 2004 IECC Supplement", as well as for commercial buildings that "achieve a 50% reduction in annual energy cost to the user, compared to a base building defined by the industry standard ASHRAE/IESNA 90.1-2001"
- Legislation proposed as HB 2858 including a LEED standard for schools, and including methods by which the degree to which schools meet the standard will be monitored.
- Legislation proposed as HB 2430 emphasizing life-cycle costing.
- Legislation proposed as HB 2429 for solar tax credits.
- Legislation proposed as HB 2843 for tax credits for high-efficiency residential central air conditioners and ceiling fans (as well as clothes washers).
- Legislation proposed as HB 2324 and recently enacted as ARS 34-451 setting energy efficiency standards for new and existing public buildings.

Types(s) of GHG Benefit(s):

- CO_2 reduction from avoided electricity production and avoided on-site fuel combustion.
- Modest reduction in CH_4 emissions from avoided fuel combustion and avoided natural gas pipeline leakage, relatively small reductions in N_2O, Black Carbon emissions from avoided fuel consumption.

Estimated GHG Savings and Costs per Ton:

Summary Results for RCI-5	2010	2020	Units
Total for Policy (Natural gas and electricity)			
GHG Emission Savings	**0.2**	**2.7**	$MMtCO_2e$
Net Present Value (2006-2020)		**-$278**	$million
Cumulative Emissions Reductions (2006-2020)		15.8	$MMtCO_2e$
Cost-Effectiveness		**-$17.65**	$/$tCO_2e$

- **Discussion of Results**: Commercial sector measures account for over half of total reduction in electricity use (and thus GHG emissions reductions). GHG emissions savings from avoided electricity generation account for over 90 percent of total reductions.

Data Sources, Methods and Assumptions (for quantified actions):

- **Data Sources:** Major data sources include the WGA CDEAC EE report, including background materials for that report developed by the Building Code Assistance Project (BCAP), The Southwest Energy Efficiency Project's (SWEEP) Report Increasing Energy Efficiency in New Buildings in the Southwest: Energy Codes and Best Practices, and results from Table 5.8 of the 2002 Energy Consumptions by Manufacturers--Data Tables published by the US Department of Energy's Energy Information Administration.

- **Quantification Methods:** Quantification starts with an estimate of average electricity use per household and per unit commercial floorspace after taking into account changes due to improved energy codes, then applies participation estimates and fractional savings assumptions to estimate potential savings, first in new construction, and then, through application of factors to reflect the participation of other types of buildings (existing, space, renovated space), estimates an overall level of electricity savings. Gas savings are estimated from electricity savings based on SWEEP data (from document above). See Attachment 1 for details.
- **Key Assumptions:** Cost of beyond-code improvements assumed to be similar to improvements needed to attain the higher codes included in RCI-4. "Beyond-code" savings assumed to save 15 percent of household and commercial electricity use (initial assumption).

Key Uncertainties: Levels of participation and savings achieved by policy in different sectors and markets.

Ancillary Benefits and Costs, if applicable[10]:

- Potential to also yield water savings, comfort/indoor air quality improvements with related improvements in health and productivity, plus urban design, market transformation, and other benefits.
- White roofs, rooftop gardens, and landscaping, if widely implemented, may have a favorable impact on local climate, for example, reducing nighttime temperatures, potentially allowing a further reduction in energy use for space cooling ("urban heat island" effects).
- Saving consumers and businesses money on their energy bills
- Reducing dependence on imported fuel sources, and reducing vulnerability to energy price spikes
- Electricity system benefits: reduced peak demand, reduced capital and operating costs, improved utilization and performance of the electricity system, reduced pollutant emissions from power plants and related public health improvements
- Supporting local businesses and stimulating economic development
- Low income populations living in buildings covered by the policy will benefit through lower annual energy costs.

Feasibility Issues, if applicable:

Status of Group Approval: (Pending or Completed)

[10] Many of these ancillary benefits are adapted from those listed on page 2 of the WGA CDEAC EE report.

Level of Group Support: (Unanimous Consent, Supermajority, Majority, or Minority)

Barriers to consensus (if less than unanimous consent):

RCI-6 Distributed Generation/Combined Heat and Power

Option Category: Quantified.

Description: Distributed generation with clean combined heat and power systems improves the overall efficiency of fuel use as well as electricity system benefits. Implementation of these systems should be encouraged through a combination of regulatory changes and incentive programs.

Design: Distributed generation in the form of clean combined heat and power systems give electricity consumers the capability of generating electricity or mechanical power on-site to meet all or part of their own needs, sell power back to the grid, and, through capture of heat typically lost during power generation, meet on-site thermal needs (hot water, steam, space heat, or process heat) or cooling (for example, through application of absorption chillers)[11]. In so doing, distributed generation with combined heat and power (CHP) raises the overall efficiency with which fuel is used. In addition to improvements in the efficiency of fuel use, and related reduction in greenhouse gas emissions, expanded use of distributed CHP offers significant electricity system benefits (including avoided electricity transmission and distribution losses, and avoided requirements for electricity grid expansion). Policies to encourage the adoption of CHP include a combination of regulatory changes and possibly incentives for adoption of CHP systems. CHP systems of 10 MW or smaller (or of equivalent mechanical power) would be covered, and policies in place by the end of 2006, and in force thereafter, with periodic review as needed. The combination of regulatory changes and incentives will be designed to allow XX percent of Arizona's estimated remaining CHP potential to be realized by the year 20xx.

Implementation method(s):

[Note that in the list of incentives below technical assistance, codes and standards, market-based mechanisms, and utility planning (in that order) are considered by TWG members to be of primary importance, while other mechanisms are considered of secondary importance.]

- Information and education: Would include training and education programs and certification for building planners, builders/contractors, energy managers and operators, and state and local officials related to the incorporation of CHP into building plans/designs/operation. Would also include programs for consumer and elementary/secondary education.

[11] The CCAG suggested that this policy option could be expanded to include on-site electricity generation from waste heat.

- Technical assistance: Assistance in siting and planning CHP systems.
- Funding mechanisms and or incentives: A program similar to that offered in California with up to $500 per kW or equivalent incentives per horsepower (hp) of capacity is possible. Another possible financial incentive are production incentives as included in the proposed legislative bill (HB 2427) of $0.015 per kWh or equivalent incentives per hp-hour.
- Voluntary and or negotiated agreements
- Codes and standards: A national IEEE standard, IEEE #1547, has been adopted to facilitate DG installations. FERC has adopted a national interconnect standard for installation to transmission lines. A number of other states, including Texas, California, New Jersey, New York- have adopted interconnect standards to facilitate DG installation. A similar standard is needed in Arizona, and has recently been under discussion at the ACC[12].
- Market based mechanisms: Net metering, avoided-cost pricing rules, and/or other utility tariff policies that promote CHP. Performance contracting is another possible mechanism, for example, HB 2430 expands the definition of allowed performance contracting for State facilities and schools to include the use of CHP, and extends the allowable payback period to 25 years (see http://www.azleg.state.az.us/FormatDocument.asp?inDoc=/legtext/47leg/2r/summary/h.hb2430_02-24-06_asengrossedandaspassedhouse.doc.htm).
- Pilots and demos: CHP systems in government buildings
- Research and development: Support for research on combined power and cooling systems most germane to Arizona
- Utility Planning: Include CHP as an element of resource planning for utilities

Related Policies/Programs in place:
Interconnection rules and similar topics are under discussion at the Arizona Corporation Commission (ACC).

Types(s) of GHG Benefit(s):

- CO_2 reduction from avoided electricity production and avoided on-site fuel combustion less additional on-site CO_2 emissions from fuel used in CHP systems.
- Other gases: modest potential changes in emissions of CH_4: from avoided fuel combustion and avoided natural gas pipeline leakage, net of any additional on-site emissions or additional leakage from increased gas use, likely relatively small reductions in emissions of N_2O:from avoided fuel combustion, net of any increased on-site emissions, and also some possible small net changes in emissions of black carbon, depending on the balance between avoided and additional consumption of oil, coal, and biomass fuels, and of emission control

[12] Includes in part text provided by the Distributed Energy Association of Arizona.

equipment used on CHP and heating systems.

Estimated GHG Savings and Costs per Ton:

Summary Results for RCI-6	2010	2020	Units
Total for Policy (All Fuels)			
Total Net GHG Emission Savings	**0.37**	**2.70**	$MMtCO_2e$
Net Present Value (2006-2020)		**-$395**	$million
Cumulative Emissions Reductions (2006-2020)		15.5	$MMtCO_2e$
Cost-Effectiveness		**-$25.41**	$\$/tCO_2e$

Discussion of Results: Net emissions reduction as calculated include consideration of avoided central station electricity generation, avoided on-site fuel use (including electricity use) for heating (or cooling) displaced by cogenerated heat and additional fuel used by CHP systems. Commercial sector measures account for over half of total reduction in electricity use (and thus GHG emissions reductions). Similarly, GHG emissions savings from avoided electricity generation account for over 90 percent of total reductions.

Data Sources, Methods and Assumptions (for quantified actions):

- **Data Sources:** The Combined Heat and Power White Paper**,** dated January, 2006, to the Clean and Diversified Energy Initiative of the Western Governors Association; and the 2003 Commercial Buildings Energy Consumption Survey Detailed Tables, published by the US Department of Energy's Energy Information Administration.
- **Quantification Methods:** Starting with an estimate for Arizona's share of CHP potential in the West, as provided in the "CHP White Paper" referenced above, assumptions regarding the penetration of and fuel shares for new CHP systems, estimates of future capacity of CHP developed under the policy are generated. Estimates of CHP cost and performance for different kinds of systems are then used to estimate the overall net GHG emissions reduction and net cost of the policy.
- **Key Assumptions:** Gas-fired systems are assumed to dominate new CHP in Arizona, but some biomass- and coal-fired capacity is also included. Systems are assumed to operate an average of 5000 hours per year (at full capacity), and 90 percent of cogenerated heat is assumed to be usable (and displaces heat from purchased fuels).

See Attachment 1 for additional information on assumptions, methods, and sources.

Key Uncertainties:

Achievable rate of implementation of CHP systems in Arizona, types and amounts of heating fuels that will be displaced, and average future costs of systems.

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Ancillary Benefits and Costs, if applicable[13]:

- Potential increased reliability of electricity supply for CHP hosts, increased flexibility of supply.
- Central-station powerplant cooling water savings
- Potential local air quality impacts (may be positive or negative)
- Saving consumers and businesses money on their energy bills
- Reducing dependence on imported fuel sources, and reducing vulnerability to energy price spikes
- Electricity (grid) system benefits: reduced peak demand, reduced capital and operating costs, improved utilization and performance of the electricity system, reduced pollutant emissions from power plants and related public health improvements
- Supporting local businesses (related to distributed generation/CHP sales, installation, and service) and stimulating economic development

Feasibility Issues, if applicable:

Status of Group Approval: (Pending or Completed)

Level of Group Support: (Unanimous Consent, Supermajority, Majority, or Minority)

Barriers to consensus (if less than unanimous consent):

RCI-7 Distributed Generation/Renewable Energy Applications

Option Category: Quantified

Description: Distributed generation sited at residences and commercial and industrial facilities, and powered by renewable energy sources, provides electricity system benefits and displaces fossil-fueled generation, thus reducing greenhouse gas emissions. Increasing the use of renewable distributed generation in Arizona can be achieved through a combination of regulatory changes and incentives.

Design: Customer-sited distributed generation powered by renewable energy sources provides electricity system benefits such as avoided capital investment and avoided transmission and distribution losses, while also displacing fossil-fueled generation and thus reducing greenhouse gas emissions. Customer-sited renewable distributed generation can include solar photovoltaic systems, wind power systems, biogas and landfill gas-fired systems, geothermal generation systems, and systems fueled with biomass wastes or biomass collected or grown as fuel. Policies to encourage and accelerate the implementation of customer-sited renewable distributed

[13] Many of these ancillary benefits are adapted from those listed on page 2 of the WGA CDEAC EE report.

generation include direct incentives for system purchase, market incentives—including "net metering"--related to the pricing of electricity output by renewable distributed generation, state goals or directives, and favorable rules for interconnecting renewable generation systems with the electricity grid. Non-electric renewable energy applications also covered by this policy include solar water heat and solar space heat and cooling. It is suggested that Arizona should, at a minimum, set as its target the addition of customer-sited distributed renewable generation consistent with the overall generation capacity by year goals for renewable distributed generation in the West as expressed in the WGA CDEAC reports.

It is expected that implementing agencies will include Public Agencies (systems for state or other government buildings), the Arizona Corporation Commission[14], Arizona State Government, and Utilities.

Implementation method(s):

- Information and education: Would include training and education programs and certification for building planners, builders/contractors, energy managers and operators, renewable energy contractors, and state and local officials on the incorporation of distributed renewable generation and solar space/water heat in building projects. Would also include programs for consumer and elementary/secondary education.
- Technical assistance: Assistance in siting, designing, planning renewable systems
- Funding mechanisms and or incentives: *Low-interest loan programs? Rebates on capital costs? Tax incentives? Attractive rates for power purchases/net metering? Other incentives?*
- Voluntary and or negotiated agreements
- Codes and standards: Common interconnection rules and standards are needed. A national IEEE standard, IEEE #1547, has been adopted to facilitate DG installations. FERC has adopted a national standard interconnect standard for installation to transmission lines. In addition, States, including Texas, California, New Jersey, and New York, have adopted interconnect standards to facilitate DG installation[15].
- Market based mechanisms: Net metering for some renewable distributed generation systems, and avoided-cost pricing rules for others[16]*[?]*

[14] In addition to the ACC's influence on interconnection and pricing rules that will have a significant impact on the adoption of customer-sited distributed generation, decisions by the ACC on reserving a portion of the Environmental Portfolio Standard to be supplied by customer-sited DG systems will also have an impact on the future implementation of DG renewable energy.

[15] Includes in part text provided by the Distributed Energy Association of Arizona.

[16] TWG members identified the need to coordinate with and support the ongoing ACC process on net metering as an important means toward achieving substantial use of distributed generation in Arizona. HB 2427 entitled "Tax Credit; Renewable Energy" creates new state income tax credits of 1.5 cents per kWh of electricity generation (and 1.1 cents per hp-hr of mechanical

- Pilots and demos: *Renewable systems in government buildings?*
- Research and development: Support for development of distributed renewable generation systems most germane to Arizona.
- Regulatory: Complete Environmental Portfolio Standard (EPS) process at the Arizona Corporation Commission, and complete Sustainable Energy process at the Salt River Project[17].

Related Policies/Programs in place:

Salt River Project's Solarwise program; TEP and UES Sunshare PV buydowns; Arizona's state Solar and Wind Equipment Sales Tax Exemption; and existing Solar and Wind Energy Systems Tax Credits.

Types(s) of GHG Benefit(s):

- CO_2 reduction from avoided fossil-fueled electricity production.
- Modest reduction in emissions of CH_4 from avoided fuel combustion in electricity generation and avoided natural gas pipeline leakage. Likely small reductions in N_2O and Black Carbon emissions from avoided fuel combustion in electricity generation.

Estimated GHG Savings and Costs per Ton:

Summary Results for RCI-7	2010	2020	Units
Total for Policy (All Fuels)			
Total Net GHG Emission Savings	**0.10**	**2.07**	$MMtCO_2e$
Net Present Value (2006-2020)		**$293**	$million
Cumulative Emissions Reductions (2006-2020)		9.6	$MMtCO_2e$
Cost-Effectiveness		**$30.62**	$/t$CO_2e$

Discussion of Results: Net emissions reductions as calculated include consideration of avoided central station electricity generation, less modest net GHG emissions from additional fuel use (biomass, biogas, and landfill gas). Most of the costs and savings from this policy are from installation of solar PV systems; under current assumptions, a cumulative 850 MW of Solar PV are installed through 2020.

Data Sources, Methods and Assumptions:

- **Data Sources:** Arizona "State Fact Sheet" from the Southwest Energy Efficiency Project's

energy produced), beginning in 2007, for individual or corporate taxpayers who produce and sell power from "qualified energy resources", including solar, wind, closed-loop biomass, geothermal, small irrigation power, and combined heat and power. See http://www.azleg.state.az.us/FormatDocument.asp?inDoc=/legtext/47leg/2r/summary/h.hb2427_02-21-06_caucuscow.doc.htm.

[17] Includes in part text provided by the Distributed Energy Association of Arizona.

Report Increasing Energy Efficiency in New Buildings in the Southwest: Energy Codes and Best Practices; USDOE/EIA document 2003 Commercial Buildings Energy Consumption Survey Detailed Tables; Worksheet "Solar Homes Summary table.xls", with calculations in support of the California Million Solar Homes Initiative, authored by XENERGY, Inc., and provided by M. Lazarus; Arizona Consumer's Guide to Buying a Solar Electric System, from the Arizona Solar Center; sources with information on Photovoltaic costs.

- **Quantification Methods:** Projection of the number of new and existing homes, and new and existing commercial floorspace, in Arizona through 2020 were coupled with an initial estimate for the penetration of solar PV panels and estimates of solar PV current and future costs to yield estimates of solar PV capacity and performance by year.
- **Key Assumptions:** Rates of growth of housing and commercial floorspace; addition of residential and commercial PV systems at a penetration rate roughly consistent with that assumed for the "Million Solar Homes" initiative in California; annual solar capital cost reductions of about 5 percent, and addition of a total of 10 MW of new customer-sited biomass/landfill gas/biogas-fueled capacity per year by 2020.

See Attachment 1 for additional information on assumptions, methods, and sources.

Key Uncertainties: Future solar PV costs, solar PV penetration rates.

Ancillary Benefits and Costs, if applicable:

- Information and education: Would include training and education programs and certification for building planners, builders/contractors, energy managers and operators, renewable energy contractors, and state and local officials on the incorporation of distributed renewable generation and solar space/water heat in building projects. Would also include programs for consumer and elementary/secondary education.
- Technical assistance: Assistance in siting, designing, planning renewable systems
- Funding mechanisms and or incentives: *Low-interest loan programs? Rebates on capital costs? Tax incentives? Attractive rates for power purchases/net metering? Other incentives?*
- Codes and standards: Common interconnection rules and standards are needed. A national IEEE standard, IEEE #1547, has been adopted to facilitate DG installations. FERC has adopted a national standard interconnect standard for installation to transmission lines. In addition, States, including Texas, California, New Jersey, and New York, have adopted interconnect standards to facilitate DG installation[18].
- Market based mechanisms: Net metering for some renewable distributed generation systems, and avoided-cost pricing rules for others[19]*[?]*

[18] Includes in part text provided by the DEAA.
[19] [Include text on need to coordinate with/support ACC process on net metering.] HB 2427 entitled "Tax Credit; Renewable Energy" creates new state income tax credits of 1.5 cents per kWh of electricity generation (and 1.1 cents per hp-hr of mechanical energy produced), beginning in 2007, for individual or corporate taxpayers who produce and sell power from

- Pilots and demos: *Renewable systems in government buildings?*
- Research and development: Support for development of distributed renewable generation systems most germane to Arizona.
- Regulatory: Complete Environmental Portfolio Standard (EPS) process at the Arizona Corporation Commission, and complete Sustainable Energy process at the Salt River Project[20].

Feasibility Issues, if applicable:

Status of Group Approval: (Pending or Completed)

Level of Group Support: (Unanimous Consent, Supermajority, Majority, or Minority)

Barriers to consensus (if less than unanimous consent):

RCI-8 Electricity Pricing Strategies

Option Category: Not Quantified (Quantification of pricing strategies that reduce electricity demand significantly still TBD)

Description: Adjustments in electricity pricing to reflect the true time-dependent cost and value of generation are suggested as means to both lower the overall costs and emissions from electricity system operation and to encourage the implementation of clean customer-sited combined heat and power and distributed generation.

Design: As with other energy and non-energy commodities, the pricing of electricity—including electricity from the grid used by consumers and electricity generated on the consumers' premises flowing to the grid—can have a significant impact on consumers' usage decisions. Proper and clear electricity tariffs and price signals can provide significant encouragement to distributed generation, energy conservation (in many forms), and reduction of electricity use during times of peak electricity demand. Creating such tariff structures may involve restructuring tariffs to provide incentives for "shoulder[21]" and peak demand reduction—for example, through implementation of time-of-use energy charges—as well as setting net metering or other rules for

"qualified energy resources", including solar, wind, closed-loop biomass, geothermal, small irrigation power, and combined heat and power. See http://www.azleg.state.az.us/FormatDocument.asp?inDoc=/legtext/47leg/2r/summary/h.hb2427_02-21-06_caucuscow.doc.htm.

[20] Includes in part text provided by the Distributed Energy Association of Arizona.

[21] "Shoulder" periods of electricity demand occur in the periods before and after the period of daily system peak power demand.

sales from distributed generation to the grid that provide appropriate credit for the electricity generated during periods of high power demand[22]. Changes in tariff structures are also needed that revise the balance between energy and demand charges and change the way that demand charges are fixed. These changes should be designed so as to provide improved incentives for end-users to adjust the timing of energy use so as to reduce greenhouse gas emissions as much as possible.

These tariff and pricing changes should be implemented by 20xx so as to remove barriers to and create incentives for customer-sited CHP and renewable generation as soon as possible. Note that it will likely not be possible to isolate the impacts of these tariff and pricing changes from policies such as RCI-1, RCI-2, RCI-6, and RCI-7, and as such the costs and impacts of these tariff and pricing policies will likely be taken into account in the quantification of costs and impacts other RCI policies (which RCI-8 policies support). To avoid double counting, then, the costs and impacts of tariff and pricing changes will likely not be quantified separately[23].

These tariff and pricing changes should be implemented by *20XX* so as to remove barriers to and create incentives for customer-sited CHP and renewable generation as soon as possible.

Implementation method(s):

Note that in the list of incentives below, rate designs, codes and standards, market-based mechanisms, and funding mechanisms and/or incentives (in that order) are considered by the TWG to be of primary importance, while other mechanisms are considered of secondary importance.

- Information and education: Would include programs for consumer education, information for distributed generation hosts.
- Technical assistance: Assistance to consumers/potential distributed generation hosts in economic analysis of potential systems
- Funding mechanisms and or incentives: Pricing incentives/TOU pricing
- Codes and standards: Common interconnection rules and standards are needed. A national IEEE standard, IEEE #1547, has been adopted to facilitate DG installations. FERC has adopted a national interconnect standard for installation to transmission lines. In addition, several States, including Texas, California, New Jersey, and New York, have adopted interconnect standards to facilitate DG installation[24].

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[22] *A CCAG member noted that tariff changes that result in a shift in demand will not necessarily result in a reduction of carbon emissions from electricity generation, as emissions changes will depend on which generation units are affected by shifts in load.*

[23] *A CCAG member suggested that those pricing strategies that result in a net reduction in electricity consumption might result in quantifiable savings, and suggested that "moderate importance" be placed on further investigating such strategies, and that the topic be addressed in the next RCI TWG meeting.*

[24] Portions of this description and that of item "xi." were adapted from text provided by the Distributed Energy Association of Arizona through TWG member Penny Allee Taylor.

- Market based mechanisms: Net metering for some renewable distributed generation/CHP systems, avoided-cost pricing rules for others, TOU tariffs
- Pilots and demos: Pilot TOU rate implementation, and pilot renewable and CHP systems in government buildings, with tracking of costs/income
- Research and development: Support for development of electricity pricing systems
- Rate Designs: Incorporate new rate designs in current DG Workshops and upcoming APS rate case. Legislative action may be needed requiring new Salt River Project standards be implemented.

Related Policies/Programs in place:
APS Commercial Peak Reduction Campaign

Types(s) of GHG Benefit(s):
Policy contributes to:

- CO_2 reduction from avoided electricity production and avoided on-site fuel combustion less additional on-site CO_2 emissions from fuel used in CHP systems.
- Other gases: modest potential changes in emissions of CH_4: from avoided fuel combustion and avoided natural gas pipeline leakage, net of any additional on-site emissions or additional leakage from increased gas use, likely relatively small reductions in emissions of N_2O:from avoided fuel combustion, net of any increased on-site emissions, and also some possible small net changes in emissions of black carbon, depending on the balance between avoided and additional consumption of oil, coal, and biomass fuels, and of emission control equipment used on CHP and heating systems.

Estimated GHG Savings and Costs per Ton (for quantified actions):

[NOT YET COMPLETE]

Data Sources, Methods and Assumptions (for quantified actions):

- Data Sources: Regional or statewide estimates of consumer-sited CHP and renewable generation potential *[?];* Case studies of the impacts of TOU rates on load shapes *[?]*. For impacts of increasing block rate and similar tariff structures, SWEEP "New Mother Lode" study, studies of similar programs in Utah and elsewhere.
- **Quantification Methods**: Note that it will likely not be possible to isolate the impacts of these tariff and pricing changes from policies such as RCI-1, RCI-2, RCI-6, and RCI-7, and as such the costs and impacts of these tariff and pricing policies will likely be taken into account in the quantification of costs and impacts other RCI policies (which RCI-8 policies support). The net impacts of TOU rates may be positive or negative, but probably should be assessed as a part of other policies. To avoid double-counting, then, the costs and impacts of tariff and pricing changes will likely not be quantified separately, with the possible exception

of tariff structures (such as increasing block rates) that may yield significant overall demand reduction.

- **Key Assumptions:** Impact of suggested policies on uptake of consumer -sited CHP and renewable generation in Arizona; impact of TOU rates on utility load curves.

Key Uncertainties:

Ancillary Benefits and Costs, if applicable[25]:

- Increased flexibility of electricity supply for consumers hosting generation.
- Central-station powerplant cooling water savings
- Potential local air quality impacts (may be positive or negative, depending on technology)
- For pricing that induces new distributed generation, saving consumers and businesses money on their energy bills (and/or offering a new income stream)
- Some pricing structures may have negative impacts on low-income consumers—need to adopt rate designs or mitigating programs to address such impacts as a part of implementation strategies.
- Reducing dependence on imported fuel sources, and reducing vulnerability to energy price spikes
- Where waste biomass fuels are used, possible reduction in disposal cost, reduction in environmental impacts related to disposal
- Electricity (grid) system benefits: reduced peak demand, reduced capital and operating costs, improved utilization and performance of the electricity system, reduced pollutant emissions from power plants and related public health improvements
- Supporting local businesses (related to renewable system sales, installation, and service, and possibly biomass fuel supply) and stimulating economic development

Feasibility Issues, if applicable:

Status of Group Approval: (Pending or Completed)

Level of Group Support: (Unanimous Consent, Supermajority, Majority, or Minority)

Barriers to consensus (if less than unanimous consent):

[25] Some of these ancillary benefits are adapted from those listed on page 2 of the WGA CDEAC Energy Efficiency Task Force report.

RCI-9 Mitigating High Global Warming Potential (GWP) Gas Emissions (HFC, PFC)

Option Category: Quantified or Not Quantified (TBD)

Description: A combination of voluntary agreements with industries and of new specifications for key equipment is suggested to reduce the emissions of process gases that have high global warming potential.

Design: Based on the current AZ emissions inventory and projection, GHG emissions from hydrofluorocarbons (HFCs) could grow from about 1 $MMtCO_2e$ or <1% of Arizona GHG emissions in 2000 to over 7 $MMtCO_2e$ or about 5% of state emissions by 2020. Most HFC emissions are expected to result from leaks in mobile air conditioning and refrigeration applications. Other sources of high Global Warming Potential (GWP) gases, which include the emission of perfluorocarbons (PFCs) and HFCs and from semiconductor manufacture and leakage of sulfur hexafluoride (SF6) from electricity distribution equipment, contribute less to state emissions, and these emissions are expected to decline based on existing emission reduction efforts, such as the semiconductor industry's voluntary worldwide agreement.

Based on a review of available options to further reduce high-GWP gas emissions in the RCI sectors, the TWG suggests further consideration of specifications for new commercial refrigeration equipment. Such specifications—now under consideration in California—would: a) promote the use of low GWP refrigerants[26] in refrigerators in retail food stores, restaurants, and refrigerated transport vehicles (trucks and railcars); and/or b) require or provide incentives that centralized systems with large refrigerant charges and long distribution lines be avoided in favor of systems that use much less refrigerant and lack long distribution lines[27].

While a focus on commercial refrigeration emerged from TWG discussions, participants also noted that maintaining momentum of voluntary industry-government partnerships (such as the semi-conductor industry agreement) should be a high priority.

Implementation method(s): These could consist of hybrid approach, combining market-based incentives and codes and standards (specifications).

Related Policies/Programs in place:

- The Intel voluntary agreement noted above is producing significant reductions in PFC emissions from semiconductor manufacturing.

Types(s) of GHG Benefit(s): This policy option would directly reduce HFC emissions. There is

[26] Examples include lower GWP HFCs, carbon dioxide, and hydrocarbons (HCs - propane or isobutene/propane blend).

[27] *A CCAG member suggested following up in additional detail the specifications for using substitute for high-GWP gases now being discussed or in place in California, and which might be considered for Arizona. Another CCAG member noted that there are existing data on reduction of PFC use in the electronics industry that should be reviewed by the TWG. Also mentioned by the CCAG was the desire to consider progress in the reduction of SF_6 use in the electric utility sector.*

a possible rebound effect if substitute refrigerants are used and are less energy-efficient, which might increase CO2 emissions from electricity production.

Estimated GHG Savings and Costs per Ton (for quantified actions):

Data Sources, Methods and Assumptions (for quantified actions):

Direct estimates of state-level HFC emissions from commercial refrigeration are not available, but emissions can be roughly estimated from USEPA reports and emissions factors. Emission reduction estimates can be drawn from various sources, including US EPA studies[28] and in consultation with California EPA staff.

- **Data Sources:**
- **Quantification Methods:**
- **Key Assumptions:**

Key Uncertainties:

Ancillary Benefits and Costs, if applicable:

Feasibility Issues, if applicable:

Status of Group Approval: (Pending or Completed)

Level of Group Support: (Unanimous Consent, Supermajority, Majority, or Minority)

Barriers to consensus (if less than unanimous consent):

RCI-10 Demand-Side Fuel Switching

Option Category: Quantified.

Description: Reductions in greenhouse gas emissions can be achieved in the residential, commercial and industrial end-use sectors when consumers switch to the use of less carbon-intensive fuels to provide key energy services.

Design: Fuel switching opportunities can include using natural gas in the place of electricity for thermal end-uses, natural gas in the place of coal for key industrial end-uses, biomass fuels in the place of electricity or natural gas for thermal end-uses, and solar thermal energy in the place of electricity or natural gas for thermal end-uses.

[28] See, for example, US EPA 2001, *U.S. High GWP Gas Emissions 1990–2010: Inventories, Projections, and Opportunities for Reductions*, June 2001. EPA 000-F-97-000.

The TWG suggests the two following options:

- The promotion of solar water heating through a combination of incentives and targeted research. These would build on incentives that already exist in the State.
- The substitution of biofuels for diesel and gasoline use in commercial and industrial equipment. Inventory estimates suggest that diesel/distillate fuel and gasoline use in commercial and industrial sectors comprised nearly 3% of the state's emissions in 2003 (2.7 million $MMtCO_2$), thus the potential for emissions reductions could be quite significant.
- The CCAG additionally suggests that this option might be structured so as to include a "Phase I" in which switching from high-carbon fuels to lower-carbon fuels (such as from oil or coal to natural gas) is allowed, with a transition in a specified year to a "Phase II" in which only transitions to "zero carbon" fuels qualify for incentives[29].

Goals: *In order to develop a rough quantification, the CCS team used some simple placeholders for the biofuels and solar water heating options. These should not be viewed as recommendations, but rather a way to gauge emissions impacts and to kick-start of further discussions.*

- ***Biofuels.*** *There are at least two possible approaches here: a) biofuels are blended and supplied statewide as the standard filling station fuel (engine modifications unlikely to be required); b)"neat" or relatively pure biofuels (e.g. 100% biodiesel or 85% ethanol or E85) are purchased directly by consumers and used in engines or other applications with technical modifications. For simplicity, we used the former approach, and assume 10% ethanol blending in gasoline, and increasing biodiesel blending starting in 2% by 2010 and rising to 20% by 2020 (given current constraints on availability). However, this would require the the adoption of statewide biofuel standards. If this were not the case, then the estimates below would be equivalent to the use of pure biodiesel in 2% (2010) and 20% (2020) of comm./ind. diesel applications, and of E85 in around 10% of gasoline applications.*
- ***Solar Water Heat.*** *Here for illustrative purposes, only we assume that solar water heaters could provide 70% of the energy needed in 5% of water heating applications (res/comm.) by 2010 and 25% of applications by 2020. [Note that inquiries have been made to the AZ Solar Center, but responses have not been received.]*

Implementation method(s): The following mechanisms could be implicated.

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[29] *CCAG members noted the need to quantify the cost of fuel-switching alternatives on a cost per ton of carbon savings basis, as well as the need to consider incentive structures that allow the users of alternate-fuel systems to pay back incentives over time so as to reduce the cost burden on society as a whole. Another CCAG comment noted that there could be a tradeoff between new incentives provided for the use of low/no-carbon fuels and current incentives effectively in place for fossil fuels, as well as tradeoffs between the costs of action to reduce greenhouse gas emissions and the costs of inaction.*

- Further tax or other financial incentives for solar water heating systems (see BAU policies).
- Targeted research at Arizona universities and research institutions to develop new and more cost-effective solar water heating technologies.
- Policies to promote the uptake of biofuels in commercial and industrial applications (See Transportation TWG)

Related Policies/Programs in place:

- Arizona's Solar Energy Credit provides an individual taxpayer with a credit for installing a solar or wind energy device at the taxpayer's Arizona residence. The credit is allowed against the taxpayer's personal income tax in the amount of 25% of the cost of a solar or wind energy device, with a $1,000 maximum allowable limit, regardless of the number of energy devices installed.
- Arizona provides a sales tax exemption for the sale or installation of "solar energy devices". A solar energy retailer may exclude from tax up to $5,000 from the sale of each solar energy device, and a solar energy contractor may exclude up to $5,000 of income derived from a contract to provide and install a solar energy device.

Types(s) of GHG Benefit(s): Solar water heating will avoid CO_2 emissions from displaced fuel use (e.g. gas) or electricity generation. Biofuels will avoid CO_2 emissions from diesel and gasoline combustion; however, lifecycle emissions from the production of biofuels need to be considered, and these could involve N_2O emissions from crop production. Other emissions impacts are likely to be relatively insignificant.

Estimated Illustrative GHG Savings and Costs per Ton:

Summary Results for RCI-3	2010	2020	Units
Total for Policy			
GHG Emission Savings	**0.14**	**1.19**	MMtCO2e
Net Present Value (2006-2020)		not est.	$million
Cumulative Emissions Reductions (2006-2020)		7	MMtCO2e
Cost-Effectiveness		not est.	$/tCO2e
Other Key Results			
GHG Emission Savings from Solar Water Heating	0.09	0.71	MMtCO2e
GHG Emission Savings from Biodiesel	0.04	0.47	MMtCO2e
GHG Emission Savings from Ethanol	0.00	0.01	MMtCO2e

Discussion: This analysis reflects a very rough estimate of impacts as noted above. As a result, costs are not estimated.

Data Sources, Methods and Assumptions: See the attachment at the end of this document for a more detailed listing of methods, data sources, and assumptions. In summary:

- **Data Sources:** Key data sources include Argonne National Laboratory (life cycle biofuel

CO2e emissions), Lawrence Berkeley Laboratory and Public Service of New Mexico (to estimate electricity and gas used for water heating – no AZ data sources were found).
- **Quantification Methods:** The estimated emissions reductions are calculated in a straightforward manner based on multiplication of the various factors and assumptions noted here.
- **Key Assumptions:** See under "goals" above. It is assumed that most ethanol is provided from corn, and that by 2020, 20% of ethanol would be provided by cellulosic sources. Biodiesel is assumed to reduce the life-cycle GHG emissions of diesel by 78% on a tCO2e/Btu basis. For corn ethanol, the similar savings relative to gasoline are 21%, while for cellulosic ethanol the savings are 79%.

Key Uncertainties:

Ancillary Benefits and Costs:
- Potential local air pollution impacts (from switching from electricity to on-site fuels combustion, or from gas to other fuels)
- Potential local and state economic co-benefits [including rural employment] from using local biomass fuel supplies and installation of solar water heating systems.
- Biomass fuel supply/use may interact with land use, forestry, local air quality issues (from notes in the RCI TWG Policy Matrix).

Feasibility Issues, if applicable:

Status of Group Approval: (Pending or Completed)

Level of Group Support: (Unanimous Consent, Supermajority, Majority, or Minority)

Barriers to consensus (if less than unanimous consent):

RCI-11 Industrial Sector GHG Emissions Trading or Commitments

Option Category: Not Quantified

Description: Industrial sector GHG emissions trading systems, with mandatory "caps" or voluntary emissions, are a means of limiting overall emissions while providing firms with choices as to how emissions limits will be achieved.

Design: Emissions cap and trade programs and/or voluntary emissions targets are options that have been considered for systematically addressing industrial sector GHG emissions. For example, a number of large industries (such as steel and cement) are included within the European emissions trading system, and have been proposed for inclusion in national legislation. Voluntary commitments have also been adopted within the US and internationally, exemplified by the US Climate Leaders program. This policy option specifically addresses how industrial sector sources would be addressed by trading systems and/or voluntary commitments.

The TWG suggests that an important first step would be to encourage the adoption of procedures to assist in the development of organizational GHG inventories, as would be enabled by a GHG registry.

RCI TWG members believe that emissions trading[30], in general, is a good idea. TWG members feel that a regional or national program approach would be preferable to a state level one. They feel that because the CCAG is a state-level advisory group, it may exceed the mandate of the CCAG to attempt development of a straw proposal; rather, an institution at a regional level or national level would best develop the concept and design elements. A recommendation for the CCAG to consider is a request that the governor explore a regional emissions trading program in a regional forum and/or advocate for development of national program.

Implementation method(s): Emissions trading; legislation.

Related Policies/Programs in place:

Types(s) of GHG Benefit(s): Trading systems or commitments can include any or all gases (CO_2, CH_4, N_2O, HFCs, SFCs, Black Carbon) as noted above.

Key Uncertainties:

Ancillary Benefits and Costs, if applicable:

Feasibility Issues, if applicable:

Status of Group Approval: **(**Pending or Completed)

Level of Group Support: (Unanimous Consent, Supermajority, Majority, or Minority)

Barriers to consensus (if less than unanimous consent):

RCI-12 Solid Waste, Wastewater, and Water Use Management

Option Category: Quantified or Not Quantified (TBD)

[30] Some TWG members feel that reference to emissions trading should explicitly include consideration of an emissions cap. There was not full TWG consensus on this matter. Some CCAG members also felt that a cap on emissions, possibly even at the State level, should be considered, perhaps in a phased manner, with a (combined RCI and ES) cap system put in place first for utilities, with industrial sector emitters covered by the program in a later phase, although another CCAG member suggested that if industries make significant progress in reducing emissions on their own, a cap for industries may not be needed. .

Description: Policies to reduce solid waste production and related landfill methane emissions through recycling and composting, as well as policies to reduce greenhouse gas emissions related to wastewater and water use management, have not yet been considered in any detail by the RCI TWG.

Design: Possible actions to reduce GHG emissions from waste and wastewater management could include:

- Increase average statewide waste wood and mixed paper recovery rates to xx% by 20xx.
- Increase average statewide paper, plastic, metals and other materials recovery rates to xx% by 20xx.
- Implement food and yard waste composting.
- Capture and use (potentially displacing fossil fuel use) and/or flare methane at small non-NSPS landfill sites.
- Implement programs to reduce the consumption of packaging materials.

Possible actions to reduce GHG emissions through water use management include:

- Reductions in electricity needs for water pumping due to from reduced water demands by RCI users and other sectors such as agriculture and electricity generation, or due to improved water management. (Note that to the extent ground water pumping as well as surface water delivery is due to agricultural demands, the AF TWG may best address this option.)
- Recover and use (potentially displacing fossil fuel use) methane from wastewater processing activities

CCAG members suggested that these are high priority options deserving of additional attention and the involvement of those with expertise in the waste-management and other areas[31]. Options covered under RCI-12 need to be separated into logical categories and further refined.

Implementation method(s):

Related Policies/Programs in place:

Types(s) of GHG Benefit(s): Various activities could reduce in methane emissions from landfills or wastewater treatment. CO_2 emissions would be reduced from avoided fossil-fueled electricity production (due, for example, to pumping electricity savings) or on-site fuel displacement. Some small reduction in methane emissions could result from avoided fuel combustion in electricity generation and avoided natural gas pipeline leakage due to fuel displacement (modest impact).

[31] *CCAG members noted that there are a mix of different jurisdictions covered by this option, and that possible contributors to elaborating these options could include solid waste experts from the Department of Environmental Quality, operators of private landfills that receive wood wastes, and others.*

N_2O emissions might decline as the result of changes wastewater treatment methods. Other GHGs are unlikely to be significantly affected.

Estimated GHG Savings and Costs per Ton (for quantified actions):

Data Sources, Methods and Assumptions (for quantified actions):

- **Data Sources:**
- **Quantification Methods:**
- **Key Assumptions:**

Key Uncertainties:

Ancillary Benefits and Costs: These could include:

- Reduced cost of electricity for water pumping, displaced fuels costs for users of landfill gas and captured gas from waste treatment facilities.
- Central-station powerplant cooling water savings
- Potential local air quality impacts (may be positive or negative, depending on technology)
- Reducing dependence on imported fuel sources, and reducing vulnerability to energy price spikes
- Reduction in disposal cost, reduction in environmental impacts related to disposal of wastes that are recycled and/or composted
- Sales of soil amendments from composted materials (and increased soil fertility from use of materials)
- Income from sales of recycled materials
- Reduction of impacts related to manufacturing of new materials through recycling
- Potential electricity (grid) system benefits: reduced peak demand, reduced capital and operating costs, improved utilization and performance of the electricity system, reduced pollutant emissions from power plants and related public health improvements
- Supporting local businesses (related to recycling, composting) and stimulating economic development

Feasibility Issues, if applicable:

Status of Group Approval: (Pending or Completed)

Level of Group Support: (Unanimous Consent, Supermajority, Majority, or Minority)

Barriers to consensus (if less than unanimous consent):

Attachment 1. Detailed Description of Data Sources, Methods, and Assumptions

Common Assumptions for Arizona RCI GHG Analysis

Date Last Modified: 4/18/2006 M. Lazarus

Common Assumptions

Real Discount Rate	**5%**	
Levelized, Avoided Costs (2006-2020, 2005$)		
Electricity - Delivered (All Sectors)	**$75**	$/MWh

Electricity prices are used as a proxy for avoided, delivered (e.g. including incremental T&D) electricity costs. Value for 2004 is based on DOE data http://www.eia.doe.gov/cneaf/electricity/esr/esr_sum.html. Changes from 2005 to 2020 are based on the relative changes in projected Mountain region prices in US DOE Annual Energy Outlook 2006 (same % changes). AEO 2006 projects prices to rise through 2007, then declining to below 2004 levels from 2010 onward.

Electricity - Residential, Delivered	**$83**	$/MWh
Electricity - Commercial, Delivered	**$72**	$/MWh
Electricity - Industrial, Delivered	**$56**	$/MWh
Natural Gas (Delivered, RCI sales-weighted average)	**$9.0**	$/MMBtu

Natural gas prices are used as a proxy. Same approach as described for electricity above.

Natural Gas - Residential, Delivered	**$11.1**	$/MMBtu
Natural Gas - Commercial, Delivered	**$7.8**	$/MMBtu
Natural Gas - Industrial, Delivered	**$5.8**	$/MMBtu

	2010	2020	Units
Electricity T&D losses (fraction of total generation)	**10.4%**	**10.4%**	
Avoided electricity emissions rate	**0.723**	**0.770**	tCO_2/MWh

Assumes that reductions in electricity generation requirements through 2010 will come from the average emissions rate of then-existing fossil-fueled sources; by 2020 the predominant effect is assumed to be a reduction in reference case new coal and gas builds during the 2010-2020 period.

RCI-1 Demand-Side Efficiency Goals, Funds, Incentives, & Programs

Date Last Modified: 4/17/2006 M. Lazarus

Key Data and Assumptions		2010	2020/all	Units
First Year Results Accrue			**2007**	
Electricity				
Savings Goal		**5%**	**15%**	
These savings targets reflect cumulative (from today), verified savings as a percentage of that years' loads, as currently projected.				
Fraction of AZ electricity use covered by measure		**100%**	**100%**	
Assumed Current (BAU) Spending on Efficiency			**$12**	$million/yr
Based on SWEEP fact sheet (2005). http://www.swenergy.org/factsheets/AZfactsheet.pdf May need to be updated for newer utility efforts. This level is assumed to continue through 2020, and is used to estimate BAU savings not currently included in the forecast. These savings are deducted from savings induced by this policy options, and reported separately.				
Levelized Cost of Electricity Savings			**$25**	$/MWh
Based on WGA CDEAC EE (2005), which in turn is based on Funding and Savings for Energy Efficiency Programs in Program Years 2000 through 2004 (CEC Rogers, Messenger Bender 2005) and on The Fifth Northwest Electric Power and Conservation Plan (Northwest Power and Conservation Council 2005)				
Electricity Savings per Program Spending (first year savings)			**6**	MWh/$1000 spent, or
			$167	$/MWh 1st yr savings
Based on rough average of several sources. Since 2000, NW utilities have achieved around 7 MWh/$1000 (T. Eckman, 2006, ttp://www.nwcouncil.org/energy/present/idaho.pdf), while CA utilities have averaged closer to 5 MWh/$1000 (M. Messenger, 2003, http://www.energy.ca.gov/reports/2003-09-24_400-03-022D.PDF).				
Average Statewide Electricity Price	in 2004		**$77**	$/MWh
Average for all sectors, based on DOE data http://www.eia.doe.gov/cneaf/electricity/esr/esr_sum.html, inflated from 2004$ to 2005$. Used to calculate fraction of future revenues spent on efficiency programs. Average electricity price is projected to change based on US DOE Annual Energy Outlook 2006 projections for SW region (same % changes). AEO 2006 projects prices to rise through 2007, then declining to below 2004 levels from 2010 onward.				
Avoided Delivered Electricity Cost			**$75**	$/MWh
See common assumptions				
Natural Gas				
Natural Gas Spending Target (as fraction of utility revenues)			**1.5%**	
Fraction of statewide gas *use/sales/revenues* covered by measure			**100%**	
Recent Actions not included in forecast (current/planned efficiency spending levels)				
Recent Southwest Gas/ACC Ruling (fraction of revenues to be spent)			**0.8%**	
Natural Gas Savings per Program Spending			**72,700**	MCF/yr per $million
			74,881	MBtu/yr per $million
Based on average cost of gas DSM programs reported in Tegen, S. and Geller, H., 2006. Natural Gas Demand-Side Management Programs: A National Survey, Southwest Energy Efficiency Project, www.swenergy.org.				
Levelized Cost of Natural Gas Savings			**$2.1**	$/MMBtu
Based on the first year costs above and average measure lifetime assumption below				
Assumed average measure lifetime			**8**	years
Avoided Delivered Natural Gas Cost			**$9.0**	$/MMBtu
See common assumptions				

RCI-2 State Lead-by-Example

Date Last Modified: 4/17/2006 M. Lazarus

Key Data and Assumptions	2010	2020/all	Units

Four options:

a) All Buildings: Energy/ft2 target. Further 15% reduction in energy use per square foot in state buildings from 2011 to 2020, along with purchasing of EnergyStar equipment

Savings from Recent Actions not included in forecast (current state building savings goals)			
Base Year for Savings Target		2003	
End Year		2010	
Savings level (Reduction from base year to 2010 in energy use/ft2)		15%	

Policy Savings

Only quantify extension of state building energy savings goals (Statute A.R.S. 34-45) to include a further 15% reduction in energy use per square foot in state buildings from 2011 to 2020. Purchasing of EnergyStar equipment not quantified (but may be included in other measures e.g. RCI-1). Assume for now that energy/ft2 savings are proportional to electricity use in that year.

Base Year for Savings Target		2011	
End Year		2020	
Savings level (Reduction from base year to end year in energy/ft2)		15%	
Fraction of Commercial Sector Energy Use attributable to state buildings			
Electricity		5%	
Natural gas		5%	

Placeholder assumption. Typically, government buildings account for 10% of commercial energy use. This assumes half is local, half state.

Levelized Cost of Electricity Savings		$47	$/MWh

Based on Osborn, J., C. Goldman, N. Hopper, and T. Singer. 2002. Assessing the U.S. ESCO Industry Performance and Market Trends: Results from the NAESCO Database Project. LBNL-50304. Berkeley, CA: Lawrence Berkeley National Laboratory, as cited in WGA CDEAC EE (2005), based on estimated 7-year payback.

Levelized Cost of Natural Gas Savings		$2	$/MMBtu

Based on WGA CDEAC EE (2005), which in turn is based on estimated 7-year payback from review LBNL/NAESCO database (Osborn et al. 2002).

b) Green Power Procurement: Governor should require state buildings – including schools – to purchase, install and operate cost-effective renewable energy equipment or purchase green power to meet 5% of their building energy needs over a phased-in period by 2012

Policy Start Year		2007	
Target Year for Achieving Purchase Level (with gradual phase-in)		2012	
Fraction of electricity purchased as green power		5%	
Incremental Cost of Green Power		$9.0	$/MWh

This represents the approximate added consumer cost of green power, assuming bulk purchase (see e.g. Pacificorp BlueSky program at http://www.pacificpower.net/Article/Article51258.html where purchases of over 75 MWh/mo pay $8.7/MWh), and assumes, for now, that the incremental cost stays constant through 2020. This is a rough approximation. The incremental cost (and cost-effectiveness) of this measure may also be reflected in the cost of the RPS policy (see ES group), since it considers costs at the wholesale not retail level, from an economic rather than financial perspective.

RCI-2 State Lead-by-Example

Date Last Modified: *4/20/2006 M. Lazarus*

Key Data and Assumptions	2010	2020/all	Units

a) All Buildings: Energy/ft2 target. Further 15% reduction in energy use per square foot in state buildings from 2011 to 2020, along with purchasing of EnergyStar equipment

Savings from Recent Actions not included in forecast (current state building savings goals)			
Base Year for Savings Target		2003	
End Year		2011	
Savings level (Reduction from base year to end year in energy/ft^2)		15%	

Policy Savings

Only quantify extension of state building energy savings goals (Statute A.R.S. 34-45) to include a further 15% reduction in energy use per square foot in state buildings from 2011 to 2020. Purchasing of EnergyStar equipment not quantified (but may be included in other measures e.g. RCI-1). Assume for now that energy/ft^2 savings are proportional to electricity/gas use in that year (i.e. no change in average energy use per ft^2)

Base Year for Savings Target		2011	
End Year		2020	
Savings level (Reduction from base year to end year in energy/ft^2)		15%	
Current State Building Energy Consumption			
Electricity Use (State Agencies and Universities)		895	GWh
adder for underreporting and leased space (with utilities in lease cost)		10%	
Gas Use (State Agencies and Universities)		2,381	Billion BTU
adder for underreporting and leased space (with utilities in lease cost)		10%	

Preliminary estimates for 2004 consumption above were provided by Jim Westberg, Energy Program Administrator, Arizona Department of Commerce (4/19/05). These are rough estimates subject to further refinement.

Rate of growth in state building space		4.9%	per year

Assumed (for now) to grow with commercial sector GSP (as assumed in state forecast).

Levelized Cost of Electricity Savings		$47	$/MWh

Based on Osborn, J., C. Goldman, N. Hopper, and T. Singer. 2002. Assessing the U.S. ESCO Industry Performance and Market Trends: Results from the NAESCO Database Project. LBNL-50304. Berkeley, CA: Lawrence Berkeley National Laboratory, as cited in WGA CDEAC EE (2005), based on estimated 7-year payback.

Levelized Cost of Natural Gas Savings		$2	$/MMBtu

Based on WGA CDEAC EE (2005), which in turn is based on estimated 7-year payback from review LBNL/NAESCO database (Osborn et al. 2002).

b) Green Power Procurement: Governor should require state buildings – including schools – to purchase, install and operate cost-effective renewable energy equipment or purchase green power to meet 5% of their building energy needs over a phased-in period by 2012

Policy Start Year		2007	
Target Year for Achieving Purchase Level (with gradual phase-in)		2012	
Fraction of electricity purchased as green power		5%	
Incremental Cost of Green Power		$9.0	$/MWh

This represents the approximate added consumer cost of green power, assuming bulk purchase (see e.g. Pacificorp BlueSky program at http://www.pacificpower.net/Article/Article51258.html where purchases of over 75 MWh/mo pay $8.7/MWh), and assumes, for now, that the incremental cost stays constant through 2020. This is a rough approximation. The incremental cost (and cost-effectiveness) of this measure may also be reflected in the cost of the RPS policy (see ES group), since it considers costs at the wholesale not retail level, from an economic rather than financial perspective.

RCI-3 Appliance Standards

Date Last Modified: *4/17/2006 M. Lazarus*

Key Data and Assumptions	2010	2020/all	Units
First Year Results Accrue		**2008**	
Electricity			
Projected Electricity Savings from 15 Proposed Standards (in 2020)		**1,105**	GWh
Projected Natural Gas Savings from 15 Proposed Standards (in 2020)		**254**	million ft3
Projected NPV Savings (to 2030, $2005)		**$651**	million

The above findings are drawn from ASAP and ACEEE, 2006. "Leading the Way: Continued Opportunities for New State Appliance and Equipment Efficiency Standards,"http://www.standardsasap.org/stateops.htm. The NPV results were derived using a 5% discount rate, and electricity prices of 9.0c/kWh ($13.52/Mbtu gas) residential and 7.6c/kWh ($9.65/Mbtu gas) commercial. The resulting NPV savings are thus slightly higher than would be obtained using our avoided delivered electricity and gas cost estimates.

Adjustment factor for NPV timespan		**0.696**	

This is the ratio of NPV values from 2006-2020 vs. 2005-2030 for a constant net benefit starting in 2008.

Adjustment factor for different electricity and gas avoided costs		**1.000**	

TBD.

RCI-4 Building Standards/Codes for Smart Growth

Date Last Modified: *4/21/2006 D. Von Hippel*

Key Data and Assumptions	2010	2020/all	Units
First Year Results Accrue		2008	
Electricity	**2010**	**2020/all**	**Units**
Levelized Cost of Electricity Savings		$47	$/MWh
Based on estimate in WGA CDEAC EE Report. (See Note 1, below.)			
Levelized Cost of Natural Gas Savings		$0	$/MMBtu
No independent estimate for this figure yet, but it is possible, given that natural gas savings is a small part of total savings, and that space heating is a small part of energy use in Arizona, that the improvements that result in electricity use reductions provide gas use reductions practically for free. Thus the levelized cost of natural gas savings could, in fact, be as low as zero. A (very high) upper bound would result by converting the levelized cost of electricity savings to $/MMBTU (about $14/MMBtu).			
Avoided Electricity Cost		$71	$/MWh
Weighted average over total 2006-2020 electricity savings for this policy in each sector.			
Avoided Natural Gas Cost		$9	$/MMBtu

Other Data, Assumptions, Calculations	2010	2020/all	Units
Adjustment for Differential Residential Growth Assumptions between CCAG Inventory and Forecast and Inventory/Forecast in WGA CDEAC EE Report	1.00	1.00	
Adjustment for Differential Commercial Growth Assumptions between CCAG Inventory and Forecast and Inventory/Forecast in WGA CDEAC EE Report	1.00	1.00	
Adjustment for Adding More Stringent Requirements (such as selected CA Title 24 Requirements) to New Residential Codes	1.00	1.00	
Adjustment for Adding More Stringent Requirements (such as selected CA Title 24 Requirements) to New Commercial Codes	1.00	1.00	
Adjustment for Inclusion of Rennovated Residential Space as Well as New Under New Code Requirements. *(Currently set at 1.0 so that no rennovated space is included--need to ask an AZ building professional for an opinion on this value.)*		1.00	
Adjustment for Inclusion of Rennovated Commercial Space as Well as New Under New Code Requirements. *(Currently set at 1.0 so that no rennovated space is included--need to ask an AZ building professional for an opinion on this value.)*		1.00	
Adjustment for Inclusion of New Industrial Space in Estimated Savings due to New Code Requirements (applied to total residential plus commercial savings) (See ***Note 3***)		1.04	
Ratio of Electricity Savings to Gas Savings: Residential Sector	1,208	407	GWh/TBtu
Ratio of Electricity Savings to Gas Savings: Commercial Sector	2,293	2,122	GWh/TBtu

Estimated based on relative AZ savings from Building Code and Beyond Code Measures as included in SWEEP Report (See Note 2). Ratios from the SWEEP "Modest Improvement" Scenario are used, since that scenario emphasizes efficiency improvements through more rigorous energy codes.

Results	2010	2020	Units
Electricity			
Reduction in Electricity Sales: Residential	54	359	GWh (sales)
Reduction in Electricity Sales: Commercial	215	1,510	GWh (sales)
Reduction in Electricity Sales: Industrial	11	75	GWh (sales)
TOTAL Reduction in Electricity Sales	280	1,943	GWh (sales)
Reduction in Generation Requirements	312	2,170	GWh (generation)
GHG Emission Savings	**0.23**	**1.67**	$MMtCO_2e$
Economic Analysis			
Net Present Value (2006-2020)		**-$161**	$million
Cumulative Emissions Reductions (2006-2020)		10.7	$MMtCO_2e$
Cost-Effectiveness		**-$15.09**	$/tCO_2e$
Natural Gas			
Reduction in Gas Use	143	1,630	Billion BTU
GHG Emission Savings	0.01	0.09	$MMtCO_2e$
Economic Analysis			
Net Present Value (2006-2020)		**-$40**	$million
Cumulative Emissions Reductions (2006-2020)		0.4	$MMtCO_2e$
Cost-Effectiveness		**-$96.06**	$/tCO_2e$

Summary Results for RCI-4	2010	2020	Units
Total for Policy (Natural gas and electricity)			
GHG Emission Savings	**0.2**	**1.8**	$MMtCO_2e$
Net Present Value (2006-2020)		**-$201**	$million
Cumulative Emissions Reductions (2006-2020)		11.1	$MMtCO_2e$
Cost-Effectiveness		**-$18.14**	$/tCO_2e$

NOTES AND DATA FROM SOURCES

Note 1:

From The Energy Efficiency Task Force Report to the Clean and Diversified Energy Advisory Committee of the Western Governors Association.
The Potential for More Efficient Electricity Use in the Western United States, January, 2006. This report is referred to here as the "WGA CDEAC EE report" and can be found at:
http://www.westgov.org/wga/initiatives/cdeac/Energy%20Efficiency-full.pdf.

In the WGA CDEAC EE report, Building Code improvements were effectively modeled in two steps. The first, assumed to be effectively a baseline action, in the context of this (AZ CCAG) study, but called the "Current Activities" case, brought codes up to recent IIEC levels as follows:

"In particular, we assume adoption of a recent version of the IECC leads to 5% electricity savings on average in states in colder or moderate climates, and 13% savings in homes in very hot climates (AZ, TX, and NV). Regarding commercial buildings, we assume adoption of the code leads to 10% electricity savings in moderate and colder states, and 15% savings in very hot states (Kinney, Geller, and Ruzzin 2003). For California, we used estimates of the electricity savings from building code upgrades adopted in 2001 and 2005 (Mahone, et al. 2005). These savings levels are prior to the adjustment for savings realization mentioned in Table V.1" [Quote from footnote, page 40]

The second increase, to the CDEAC "Best Practices" Scenario, included the following improvements:

"This [Best Practices] scenario assumes that the International Energy Conservation Code, 2004 version, is adopted in 2007 in all states except California, as California has its own more stringent standard. It is assumed that state and/or local building energy codes are upgraded in 2011 (3% improvement) and in 2015 (additional 6% improvement). This scenario also assumes that compliance and enforcement are improved and that a 90% savings realization rate is achieved. Finally, we assume that California's current building energy codes will be upgraded in 2009 (3%), 2013 (6%) and 2017 (3%)." [Quote from page 41]

The CDEAC report provides a cost of saved energy (electricity) of 4.74 cents/kWh,
in 2005 dollars, based on an average 7-year payback for code improvements (page 42).

A set of background spreadsheets prepared by David Weitz of ASE includes estimates of the benefits of code improvements done for the CDEAC report by State and by sector (Residential and Commercial). Electricity savings by year (apparently for the year implemented only, not cummulative) and by scenario modeled are shown at right:
From workbooks: BCAP code savings estimator - WGA Scenario 2 (9-02-2005).xls and BCAP code savings estimator - WGA Scenario 3 (7-20-2005) v2.xls.

Current Activities Case--I
Current Activities Case--C
Best Practices Case--I
Best Practices Case--C

[NOTE: YEAR BY YEAR BCAP RESULTS NOT SHOWN HERE, BUT AVAILABLE UPON REQUEST]

Note 2:

The Southwest Energy Efficiency Project's Report
Increasing Energy Efficiency in New Buildings in the Southwest: Energy Codes and Best Practices
includes state-by-state estimates of the potential savings from two scenarios of building code and "beyond code" efficiency improvements. For Arizona, the results of this work are summarized in a "State Fact Sheet", available as http://www.swenergy.org/ieenb/fact_sheet_arizona.pdf. Tables from this Fact Sheet are reproduced below.

Building Stock and Projected Growth

	Housing units 2000	Housing units 2020	Growth 2000-2020 (%)	Commercial area in 2000 ($ft^2 \times 10^6$)	Commercial area in 2020 ($ft^2 \times 10^6$)	Growth 2000-2020 (%))
AZ	2,189,189	3,315,965	51	1,183	2,287	93
Region	6,597,710	9,543,226	45	3,969	7,085	79
AZ as % of Region	33	35	-	30	32	-

Source: U.S. Census; Tellus Institute

Energy Savings Potential – Residential Sector

	2010			2020		
Scenario	Total Savings (TBtu)	Total Elec Savings (GWh)	Total Gas Savings (TBtu)	Total Savings (TBtu)	Total Elec Savings (GWh)	Total Gas Savings (TBtu)
Moderate Improvement	3.1	724.5	0.6	4.8	813.3	2.0
Strong Improvement	6.9	1,622.5	1.4	16.8	2,863.7	7.0

Energy Savings Potential – Commercial Sector

	2010			2020		
Scenario	Total Savings (TBtu)	Total Elec Savings (GWh)	Total Gas Savings (TBtu)	Total Savings (TBtu)	Total Elec Savings (GWh)	Total Gas Savings (TBtu)
Moderate Improvement	4.4	1,146.5	0.5	9.8	2,546.0	1.2
Strong Improvement	9.5	2,533.0	0.8	24.1	6,543.0	1.7

Combined Residential and Commercial Costs and Savings (millions of constant 2003 dollars)

	2010			2020		
Scenario	Costs	Savings	Net Savings	Costs	Savings	Net Savings
Moderate Improvement	78.9	121.6	42.7	79.6	235.2	155.6
Strong Improvement	166.4	264.7	98.2	226.5	658.9	432.4

Net Economic Savings during 2001-2020 (billion dollars)

	SCENARIO	
State	Moderate Improvement	Strong Improvement
Arizona	1.08	2.84
Region	2.85	8.36
AZ as % of Region	38	34

From the above, the ratios of electric to gas savings for AZ, by sector and by scenario, are as follows:

	2010	2020	
Residential, Moderate Improvement	1,208	407	GWh/TBtu
Residential, Strong Improvement	1,159	409	GWh/TBtu
Commercial, Moderate Improvement	2,293	2,122	GWh/TBtu
Commercial, Strong Improvement	3,166	3,849	GWh/TBtu

Note 3:

Based on results from Table 5.8 of the 2002 Energy Consumptions by Manufacturers--Data Tables published by the US Department of Energy's Energy Information Administration, and available as http://www.eia.doe.gov/emeu/mecs/mecs2002/data02/pdf/table5.8_02.pdf, approximately 18% of industrial electricity use is used for HVAC, lighting, and "other facility support", with 6.7% of natural gas used for HVAC and "other facility support".

In Arizona, as of 2004, total electricity use in Arizona by sector was as follows (from Retail Sales of Electricity by State by Sector by Provider, downloaded from http://www.eia.doe.gov/cneaf/electricity/epa/epat7p2.html.

	MWh	Fraction of Total
Residential	28,920,651	43%
Commercial	26,106,424	39%
Industrial	11,906,176	18%
Total	66,933,251	100%

Thus industrial use of electricity for non-process uses in Arizona may be roughly 4% of total Residential and Commercial electricity use. This figure is used as an initial rule of thumb in estimating the contribution of savings from this policy from industrial sector measures.

RCI-5 "Beyond Code" Building Design Incentives and Programs for Smart Growth

Date Last Modified: *4/21/2006 D. Von Hippel*

Key Data and Assumptions	2010	2020/all	Units
First Year Results Accrue		2008	
Electricity	**2010**	**2020/all**	**Units**
Levelized Cost of Electricity Savings		$47	$/MWh
Based on estimate in WGA CDEAC EE Report. (See Note 1, below.) Although this estimate is based on building efficiency improvements driven by code changes, it is on the order of estimates for the costs of efficiency improvements for "beyond code" changes included in a recent report by the Southwest Energy Efficiency Project (SWEEP--see Note 2)			
Levelized Cost of Natural Gas Savings		$0	$/MMBtu
No independent estimate for this figure yet, but it is possible, given that natural gas savings is a small part of total savings, and that space heating is a small part of energy use in Arizona, that the improvements that result in electricity use reductions provide gas use reductions practically for free. Thus the levelized cost of natural gas savings could, in fact, be as low as zero. A (very high) upper bound would result by converting the levelized cost of electricity savings to $/MMBTU (about $14/MMBtu).			
Avoided Electricity Cost		$73	$/MWh
Weighted average over total 2006-2010 electricity savings for this policy in each sector.			
Avoided Natural Gas Cost		$9	$/MMBtu

Other Data, Assumptions, Calculations	2010	2020/all	Units
Average Electricity Savings Beyond Code Levels (all buildings)	15%	15%	
The description for this policy currently includes a requirement of using "at least 10 percent less energy per square foot of floorspace relative to what the same building would have used if designed to just meet existing energy codes" in order to qualify for incentives or--in the case of state buildings--the requirements of the policy. 15 percent is used here as an average, assuming that many buildings covered under the policy will perform beyond the minimum level. Further, the 15% is interpreted as a reduction from total building energy use, that is, not just electricity used for heating/cooling/lighting.			
"Residential Annual Growth Multiplier" used to estimate number of households and annual residential electricity use from BCAP estimates below (from BCAP workbooks, "Accumulated Savings" worksheets--see ***Note 1***)		2.32%	
Est. number of new housing units per year used as basis by BCAP in estimate of building code efficiency measures (see ***Note 1***)	102,501	128,923	
Est. total annual electricity use in new housing before code improvement savings (TWh).	1.23	1.54	
Average total electricity use per new residential housing unit (MWh) after code improvement savings (including those in RCI-4, see ***Note 1***)	10.79	10.69	
"Commercial Annual Growth Multiplier" used to estimate commercial annual electricity use for new buildings from BCAP estimates below (from BCAP workbooks, "Accumulated Savings" worksheets--see ***Note 1***)		3.30%	
Est. area of new commercial space per year based on SWEEP estimates for 2000 through 2020 (million square feet) (see ***Note 2***)	53	74	
Est. total annual electricity use in new commercial space before code improvement savings (TWh). 2005 value calculated based on BCAP estimates.	1.47	2.03	
Average total electricity use per unit new commercial floor space (MWh/sf) after code improvement savings (including those in RCI-4)	0.0235	0.0226	
Adjustment for Differential Residential Growth Assumptions between CCAG Inventory and Forecast and Inventory/Forecast in WGA CDEAC EE Report	1.00	1.00	
Adjustment for Differential Commercial Growth Assumptions between CCAG Inventory and Forecast and Inventory/Forecast in WGA CDEAC EE Report	1.00	1.00	

For the participation assumptions included in this box, the year 2010 participation level is assumed to be phased in linearly from the program start year to 2010. Participation between 2010 and 2020 is linearly interpolated between the values for 2010 and 2020.		
Fraction of Residential Housing covered by mandatory programs (for example, as a part of public housing projects, or related to housing funded in part by State grants or loans) (See ***Note 3***)	**3.5%**	**3.5%**
Fraction of Commercial new construction covered by mandatory programs (for example, as part of projects built by or with funds from the State government. (See ***Note 4***)	**12%**	**25%**
Fraction of new Residential Housing participating in incentive programs *(Placeholder estimates for aggressive programs)*	**15%**	**30%**
Fraction of new Commercial floorspace participating in incentive programs *(Placeholder estimates for aggressive programs)*	**15%**	**30%**
Ratio of Existing Residential Housing Units Participating in Programs Relative to Total New Residential Units (See ***Note 5***)	**10%**	**20%**
Ratio of Existing Commercial Floorspace Participating in Programs to Total New Commercial Floorspace (See ***Note 5***)	**12%**	**25%**

Adjustment for Inclusion of Rennovated Residential Space as Well as New Under Policy (applied to savings from all residential categories above) *(Currently set at 1.0 so that no rennovated space is included--need to ask an AZ building professional for an opinion on this value.)*	**1.00**
Adjustment for Inclusion of Rennovated Commercial Space as Well as New Under Policy (applied to savings from all commercial categories above) *(Currently set at 1.0 so that no rennovated space is included--need to ask an AZ building professional for an opinion on this value.)*	**1.00**
Adjustment for Inclusion of Industrial Space in Estimated Savings due to Policy (applied to total residential plus commercial savings) (See ***Note 6***)	**1.04**

Ratio of Electricity Savings to Gas Savings: Residential Sector	1,159	409	GWh/TBtu
Ratio of Electricity Savings to Gas Savings: Commercial Sector	3,166	3,849	GWh/TBtu

Estimated based on relative AZ savings from Building Code and Beyond Code Measures as included in SWEEP Report (See Note 2). Ratios from the SWEEP "Strong Improvement" Scenario are used, since that scenario emphasizes efficiency improvements beyond even

Results	2010	2020	Units
Electricity			
Reduction in Electricity Sales: Residential	93	893	GWh (sales)
Reduction in Electricity Sales: Commercial	143	1,515	GWh (sales)
Reduction in Electricity Sales: Industrial	16	524	GWh (sales)
TOTAL Reduction in Electricity Sales	252	2,932	GWh (sales)
Reduction in Generation Requirements	281	3,273	GWh (generation)
GHG Emission Savings	**0.20**	**2.52**	$MMtCO_2e$
Economic Analysis			
Net Present Value (2006-2020)		**-$223**	$million
Cumulative Emissions Reductions (2006-2020)		15.2	$MMtCO_2e$
Cost-Effectiveness		**-$14.69**	$/$tCO_2e$
Natural Gas			
Reduction in Gas Use	131	2,712	Billion BTU
GHG Emission Savings	0.01	0.14	$MMtCO_2e$
Economic Analysis			
Net Present Value (2006-2020)		**-$55**	$million
Cumulative Emissions Reductions (2006-2020)		0.6	$MMtCO_2e$
Cost-Effectiveness		**-$93.83**	$/$tCO_2e$

Summary Results for RCI-5	2010	2020	Units
Total for Policy (Natural gas and electricity)			
GHG Emission Savings	**0.2**	**2.7**	$MMtCO_2e$
Net Present Value (2006-2020)		**-$278**	$million
Cumulative Emissions Reductions (2006-2020)		15.8	$MMtCO_2e$
Cost-Effectiveness		**-$17.65**	$/$tCO_2e$

NOTES AND DATA FROM SOURCES

Note 1:

From The Energy Efficiency Task Force Report to the Clean and Diversified Energy Advisory Committee of the Western Governors Association.
The Potential for More Efficient Electricity Use in the Western United States, January, 2006. This report is referred to here as the "WGA CDEAC EE report" and can be found at:
http://www.westgov.org/wga/initiatives/cdeac/Energy%20Efficiency-full.pdf.

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"In particular, we assume adoption of a recent version of the IECC leads to 5% electricity savings on average in states in colder or moderate climates, and 13% savings in homes in very hot climates (AZ, TX, and NV). Regarding commercial buildings, we assume adoption of the code leads to 10% electricity savings in moderate and colder states, and 15% savings in very hot states (Kinney, Geller, and Ruzzin 2003). For California, we used estimates of the electricity savings from building code upgrades adopted in 2001 and 2005 (Mahone, et al. 2005). These savings levels are prior to the adjustment for savings realization mentioned in Table V.1" [Quote from footnote, page 40]

The second increase, to the CDEAC "Best Practices" Scenario, included the following improvements:

"This [Best Practices] scenario assumes that the International Energy Conservation Code, 2004 version, is adopted in 2007 in all states except California, as California has its own more stringent standard. It is assumed that state and/or local building energy codes are upgraded in 2011 (3% improvement) and in 2015 (additional 6% improvement). This scenario also assumes that compliance and enforcement are improved and that a 90% savings realization rate is achieved. Finally, we assume that California's current building energy codes will be upgraded in 2009 (3%), 2013 (6%) and 2017 (3%)." [Quote from page 41]

The CDEAC report provides a cost of saved energy (electricity) of 4.74 cents/kWh, in 2005 dollars, based on an average 7-year payback for code improvements (page 42).

A set of background spreadsheets prepared by the Building Code Assistance Project (BCAP) for the WGA, includes estimates of the benefits of code improvements as calculated for the CDEAC report by State and by sector (Residential and Commercial). Electricity savings by year (apparently for the year implemented only, not cummulative) and by scenario modeled are shown at right:
From workbooks: BCAP code savings estimator - WGA Scenario 2 (9-02-2005).xls and BCAP code savings estimator - WGA Scenario 3 (7-20-2005) v2.xls.

Current Activities Case--I
Current Activities Case--C
Best Practices Case--I
Best Practices Case--C

[NOTE: YEAR BY YEAR BCAP RESULTS NOT SHOWN HERE, BUT AVAILABLE UPON REQUEST]

Note 2:

The Southwest Energy Efficiency Project's Report
Increasing Energy Efficiency in New Buildings in the Southwest: Energy Codes and Best Practices
includes state-by-state estimates of the potential savings from two scenarios of building code and "beyond code" efficiency improvements. For Arizona, the results of this work are summarized in a "State Fact Sheet", available as http://www.swenergy.org/ieenb/fact_sheet_arizona.pdf. Tables from this Fact Sheet are reproduced below.

Building Stock and Projected Growth

	Housing units 2000	Housing units 2020	Growth 2000-2020 (%)	Commercial area in 2000 ($ft^2 \times 10^5$)	Commercial area in 2020 ($ft^2 \times 10^5$)	Growth 2000-2020 (%))
AZ	2,189,189	3,315,965	51	1,183	2,287	93
Region	6,597,710	9,543,226	45	3,969	7,085	79
AZ as % of Region	33	35	-	30	32	-

Source: U.S. Census; Tellus Institute

Energy Savings Potential – Residential Sector

	2010			2020		
Scenario	Total Savings (TBtu)	Total Elec Savings (GWh)	Total Gas Savings (TBtu)	Total Savings (TBtu)	Total Elec Savings (GWh)	Total Gas Savings (TBtu)
Moderate Improvement	3.1	724.6	0.6	4.8	813.3	2.0
Strong Improvement	6.9	1,622.5	1.4	16.8	2,863.7	7.0

Energy Savings Potential – Commercial Sector

	2010			2020		
Scenario	Total Savings (TBtu)	Total Elec Savings (GWh)	Total Gas Savings (TBtu)	Total Savings (TBtu)	Total Elec Savings (GWh)	Total Gas Savings (TBtu)
Moderate Improvement	4.4	1,146.5	0.5	9.8	2,546.0	1.2
Strong Improvement	9.5	2,533.0	0.8	24.1	6,543.0	1.7

Combined Residential and Commercial Costs and Savings (millions of constant 2003 dollars)

	2010			2020		
Scenario	Costs	Savings	Net Savings	Costs	Savings	Net Savings
Moderate Improvement	78.9	121.6	42.7	79.6	235.2	155.6
Strong Improvement	166.4	264.7	98.2	226.5	658.9	432.4

Net Economic Savings during 2001-2020 (billion dollars)

	SCENARIO	
State	Moderate Improvement	Strong Improvement
Arizona	1.08	2.84
Region	2.85	8.36
AZ as % of Region	38	34

From the above, the ratios of electric to gas savings for AZ, by sector and by scenario, are as follows:

	2010	2020	
Residential, Moderate Improvement	1,208	407	GWh/TBtu
Residential, Strong Improvement	1,159	409	GWh/TBtu
Commercial, Moderate Improvement	2,293	2,122	GWh/TBtu
Commercial, Strong Improvement	3,166	3,849	GWh/TBtu

The cost and energy savings figures shown above suggest the following for the "Strong Improvement" scenario:

	2010	2020	
Costs (million)	166.4	226.5	Constant 2003 dollars
TBtu Saved	9.5	24.1	Electric plus Gas
Implied $/MMBtu	17.52	9.40	
Implied $/MWh	59.76	32.07	

Note 3:
The Arizona Public Housing Authority has jurisdiction over 7500 residential housing units, or approximately 3.5% of total housing in the State (see http://www.housingaz.com/pha/phaprograms.asp).
An initial assumption is that public housing will be built in Arizona in coming years at so that this fraction is maintained (although Arizona may have fewer public housing units per capita than in other states).
Additional residential housing may participate in this program through other agencies, including Tribal Agencies.

Note 4:
Based on data in the 2003 Commercial Buildings Energy Consumption Survey Detailed Tables published by the US Department of Energy's Energy Information Administration, and available as http://www.eia.doe.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/pdf2003/allbc.pdf, government-owned buildings in the Mountain West accounted for about 25.3% of total building floorspace as of 2003. Total floorspace here includes malls, but government-owned floorspace is not reported, so if government agencies do own space in malls, this figure could be higher.
Also, the figure does not appear to count government-leased facilities. Approximately 64% of total government-owned building floorspace in the Mountain West was owned by local governments.
Data to calculate fractions above are taken from pages 5 and 44 of the source document.
The initial assumption for the fraction of new commecial floorspace covered by a government "reach code" policy is that the equivalent of all new (non-mall) government buildings are covered by 2020, phasing in from half of the potential "market" in 2010.

Note 5:
These placeholder estimates equate to retrofitting approximately 0.5% of existing homes and floorspace annually as of 2010, growing to about 1% by 2020.

Note 6:
Based on results from Table 5.8 of the 2002 Energy Consumptions by Manufacturers--Data Tables published by the US Department of Energy's Energy Information Administration, and available as http://www.eia.doe.gov/emeu/mecs/mecs2002/data02/pdf/table5.8_02.pdf, approximately 18% of industrial electricity use is used for HVAC, lighting, and "other facility support", with 6.7% of natural gas used for HVAC and "other facility support".
In Arizona, as of 2004, total electricity use in Arizona by sector was as follows (from Retail Sales of Electricity by State by Sector by Provider, downloaded from http://www.eia.doe.gov/cneaf/electricity/epa/epat7p2.html.

	MWh	Fraction of Total
Residential	28,920,651	43%
Commercial	26,106,424	39%
Industrial	11,906,176	18%
Total	66,933,251	100%

Thus industrial use of electricity for non-process uses in Arizona may be roughly 4% of total Residential and Commercial electricity use. This figure is used as an initial rule of thumb in estimating the contribution of savings from this policy from industrial sector measures.

RCI-6 Distributed Generation/Combined Heat and Power

Date Last Modified: *4/21/2006 D. Von Hippel*

Key Data and Assumptions	2010	2020/all	Units
First Year Results Accrue		**2008**	

Electricity	2010	2020/all	Units
Avoided Electricity Cost		**$72**	$/MWh
Average cost of electricity in the commercial sector, likely the most common host for CHP in Arizona, is used here as a proxy until more accurate avoided costs are available.			
Avoided Natural Gas Cost		**$7.83**	$/MMBtu
Average cost of electricity in the commercial sector, likely the most common host for CHP in Arizona, is used here as a proxy until more accurate avoided costs are available.			

Other Data, Assumptions, Calculations	2010	2020/all	Units
Fraction of Arizona's Remaining Existing CHP Potential Tapped per Year	**2.0%**	**3.0%**	
Rough estimate to be refined in consultation with TWG. Fractions of remaining potential tapped in each year are assumed to be beyond "baseline plus existing policies" levels, and thus due to CCAG policies.			
Total Remaining Estimated CHP Potential in AZ as of 2006: **1801** MW (See ***Note 1***)			
Annual Growth in CHP Potential	**3.5%**	**3.0%**	
Rough estimate based on consideration of growth in electricity use in the commercial and industrial sectors.			
Estimated CHP Potential by Year (MW)	**2,139**	**2,938**	
Estimated CHP Installed Under Policy by Year (MW)	**42.78**	**88.14**	
Average full-capacity-equivalent hours of operation for New CHP units: *(Assumption)*	**5,000**	**5,000**	
Fraction of New CHP Capacity/Energy Fueled With:			
Natural Gas	90%	85%	
Biomass	5%	12%	
Coal	5%	3%	
(Assumptions)			
Implied Annual New CHP Capacity by Fuel (MW)			
Natural Gas	**38.50**	**74.92**	
Biomass	**2.14**	**10.58**	
Coal	**2.14**	**2.64**	
Implied Cumulative New CHP Capacity by Fuel (MW)			
Natural Gas	**111.65**	**686.81**	
Biomass	**6.20**	**67.41**	
Coal	**6.20**	**31.23**	
Implied Cumulative New CHP Electricity Output by Fuel (GWh)			
Natural Gas	**558**	**3,434**	
Biomass	**31**	**337**	
Coal	**31**	**156**	

Average Net Heat Rate by Fuel (Btu Fuel Input/kWh Electricity Output)		
Natural Gas	10,000	10,000
Biomass	13,000	13,000
Coal	12,000	12,000
Implied Fuel Input by Fuel (Billion Btu)		
Natural Gas	**5,582**	**34,341**
Biomass	**403**	**4,382**
Coal	**372**	**1,874**
Usable Cogenerated Heat Output as a Fraction of Fuel Energy Input		
Natural Gas	40%	40%
Biomass	40%	40%
Coal	40%	40%
Implied Usable Heat Output by Fuel (Billion Btu)		
Natural Gas	**2,233**	**13,736**
Biomass	**161**	**1,753**
Coal	**149**	**750**
Fraction of Usable Heat Output Replacing Space/Water/Process Heat Use *(Assumption)*	90%	90%
Fraction of CHP Heat Output Displacing Thermal Energy Produced Using		
Natural Gas	75%	75%
Biomass	5%	5%
Coal	0%	0%
Electricity	15%	15%
Oil	5%	5%
Assumptions: See Note 2		
Net Efficiency of Displaced Boiler/Heater Thermal Energy Produced Using		
Natural Gas	85%	85%
Biomass	80%	80%
Coal	80%	80%
Electricity	92%	92%
Oil	80%	80%
Assumptions		
Net Displaced Fuel Use (Billion Btu)		
Natural Gas	**2,019**	**12,895**
Biomass	**143**	**913**
Coal	**-**	**-**
Electricity	**373**	**2,383**
Oil	**143**	**913**

Inputs to Cost Estimates for CHP Systems

Estimated Average Installed Capital Costs by System Type ($2005/kW)		
Natural Gas	$ 2,000	$ 1,500
Biomass	$ 2,500	$ 2,200
Coal	$ 2,500	$ 2,200

Factors for Annualizing Capital Costs (all plant types)		
Interest Rate	8%	/yr
Economic Life of System	20	years
Implied Annualization Factor	10.19%	%/yr

Estimated Average Non-fuel Operating and Maintenance Costs by System Type ($/MWh)

Natural Gas	$ 16.00	$ 16.00
Biomass	$ 20.00	$ 20.00
Coal	$ 20.00	$ 20.00

Intermediate Results for Cost Estimates

Total Capital Costs for New Systems (thousand 2005 dollars)

Natural Gas	$ 77,005	$112,381
Biomass	$ 5,348	$ 23,269
Coal	$ 5,348	$ 5,817

Annualized Capital Costs for All Systems (thousand 2005 dollars)

Natural Gas	$ 22,743	$122,241
Biomass	$ 1,579	$ 15,915
Coal	$ 1,579	$ 7,521

Annual Non-Fuel Operating and Maintenance Costs for All Systems (thousand 2005 dollars)

Natural Gas	$ 8,932	$ 54,945
Biomass	$ 620	$ 6,741
Coal	$ 620	$ 3,123

Total Non-Fuel Costs for All Systems (thousand 2005 dollars)

Natural Gas	$ 31,674	$177,186
Biomass	$ 2,200	$ 22,656
Coal	$ 2,200	$ 10,644

Total Gross Fuel Costs for All Systems (thousand 2005 dollars)

Natural Gas	$ 43,698	$268,822
Biomass	$ 1,008	$ 10,959
Coal	$ 779	$ 3,923

Total Fuel Cost Savings from Displaced Heating Fuels for All Systems (thousand 2005 dollars)

Natural Gas	$ 15,809	$100,946
Biomass	$ 358	$ 2,285
Coal	$ -	$ -
Electricity	$ 26,786	$171,041
Oil	$ 1,826	$ 11,661

Results	2010	2020	Units
Electricity			
TOTAL Reduction in Electricity Sales (electricity output from CHP plus avoided electricity use in boilers/space heaters/water heaters)	730	4,626	GWh (sales)
Reduction in Generation Requirements	815	5,165	GWh (generation)
Gross GHG Emission Savings	**0.59**	**3.98**	$MMtCO_2e$
Natural Gas			
Net Change in Gas Use (negative values denote increased use)	-3,563	-21,445	Billion BTU
Net GHG Emissions (negative values denote increased emissions)	-0.19	-1.13	$MMtCO_2e$
Biomass			
Net Change in Biomass Use (negative values denote increased use)	-260	-3,468	Billion BTU
Net GHG Emissions (negative values denote increased emissions)	-0.002	-0.024	$MMtCO_2e$
Coal			
Net Change in Coal Use (negative values denote increased use)	-372	-1,874	Billion BTU
Net GHG Emissions (negative values denote increased emissions)	-0.03	-0.18	$MMtCO_2e$
Oil			
Net Change in Oil Use (negative values denote increased use)	143	913	Billion BTU
Net GHG Emissions (negative values denote increased emissions)	0.01	0.06	$MMtCO_2e$

Summary Results for RCI-6	2010	2020	Units
Total for Policy (All Fuels)			
Total Net GHG Emission Savings	**0.37**	**2.70**	$MMtCO_2e$
Net Present Value (2006-2020)		**-$395**	$million
Cumulative Emissions Reductions (2006-2020)		15.5	$MMtCO_2e$
Cost-Effectiveness		**-$25.41**	$/tCO_2e$

NOTES AND DATA FROM SOURCES

Note 1:

From the Combined Heat and Power White Paper, dated January, 2006, to the Clean and Diversified Energy Initiative of the Western Governors Association.
This report is referred to here as the "WGA CDEAC CHP report" and can be found at: http://www.westgov.org/wga/initiatives/cdeac/CHP-full.pdf.
This report (page i, for example) give a total AZ CHP capacity of 155 MW, and a total potential additional capacity (presumably as of 2005) of 1801 MW.

Note 2:

Based on data in the 2003 Commercial Buildings Energy Consumption Survey Detailed Tables published by the US Department of Energy's Energy Information Administration, and available as http://www.eia.doe.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/pdf2003/allbc.pdf, non-mall commercial buildings in the Mountain West that used space heat used gas to heat 64.9% of floorspace (as a primary fuel), and used electricity to heat 22.1% of floorspace. (Data from Table B29).
Similarly, commercial buildings in the Mountain West that used water heat used gas to heat water for 66.5% of floorspace, and with electricity use for 36.1% of floorspace (some used both and/or other fuels). (Data from Table B32).

RCI-7 Distributed Generation/Renewable Energy Applications

Date Last Modified: *4/23/2006 D. Von Hippel*

Key Data and Assumptions	2010	2020/all	Units
First Year Results Accrue		2008	
Electricity	**2010**	**2020/all**	**Units**
Avoided Electricity Cost		$77	$/MWh

Average cost of electricity, weighted by cummulative solar capacity (MW) by sector through 2020, is used here as a proxy until more accurate avoided costs are available.

Other Data, Assumptions, Calculations	2010	2020/all	Units
Housing Units in Arizona (thousand)	2,694	3,316	
Commercial Building Area in Arizona (million square feet)	1,645	2,287	
Implied Annual New Housing Units Per Year (thousand)	55	68	
Implied Annual New Commercial Building Area in Arizona (million square feet)	53	74	
Target Fraction of Annual New Homes in AZ with Solar PV Systems	5.0%	30.0%	
Target Fraction of Existing Homes in AZ Annually Adopting Solar PV Systems	0.10%	0.70%	
Number of New Homes Installing Solar PV Systems Annually	2,768	20,440	
Number of Existing Homes Installing Solar PV Systems Annually	1,645	16,009	

Target Fraction of Annual New Homes in AZ with Solar PV Systems: *Assumption--Penetration level beyond "baseline plus existing policies" levels, and thus due to CCAG policies.*

Target Fraction of Existing Homes in AZ Annually Adopting Solar PV Systems: *Assumption--Penetration level beyond "baseline plus existing policies" levels, and thus due to CCAG policies.*

Total Number of Homes with Solar PV Systems Installed under CCAG Policy, 2008 to 2020: 216,292

Note that a cummulative ~200,000 solar PV systems by 2020 is slightly more, on a per-capita basis, than the 1.2 million solar homes by 2020 used in an estimate of solar PV contributions to GHG emissions reduction in California (see ***Note 3****).*

	2010	2020/all
Target Fraction of Annual New Commercial Space in AZ with Solar PV Systems	5.0%	30.0%
Target Fraction of Existing Commercial Buildings in AZ Annually Adopting Solar PV Systems	0.10%	0.70%
Implied number of Commercial Buildings with Solar PV Systems	324	2,873
Average Capacity of Solar PV System Installed on New Homes (kW)	2.00	2.00
Average Capacity of Solar PV System Installed on Existing Homes (kW)	3.00	3.00
Average Capacity of Solar PV System Installed on Commercial Buildings (all) (kW)	15.00	15.00

Target Fraction of Annual New Commercial Space in AZ with Solar PV Systems: *Assumption--Penetration level beyond "baseline plus existing policies" levels, and thus due to CCAG policies.*

Target Fraction of Existing Commercial Buildings in AZ Annually Adopting Solar PV Systems: *Assumption--Penetration level beyond "baseline plus existing policies" levels, and thus due to CCAG policies.*

Implied number of Commercial Buildings with Solar PV Systems: *Calculated based on building floor area estimates and 2003 average floor area per building. See* ***Note 2****.*

Average Capacity of Solar PV System Installed on New Homes (kW): *Assumption, consistent with capacity assumption used in Source in* ***Note 3****.*

Average Capacity of Solar PV System Installed on Existing Homes (kW): *Assumption, consistent with capacity assumption used in Source in* ***Note 3****.*

Average Capacity of Solar PV System Installed on Commercial Buildings (all) (kW): *Assumption, roughly consistent, per square foot of floor area, with capacity assumptions for new and existing residential buildings used in Source in* ***Note 3****.*

Capacity of PV Installed on Industrial Buildings Relative to Capacity on Commercial Buildings	0.36	0.28
*Assumption, consistent with estimated ratio of industrial to commercial sector electricity sales. See **Note 5**.*		
Total Annual Residential Solar PV Capacity Installed on New Homes (MW)	5.54	40.88
Total Annual Residential Solar PV Capacity Installed on Existing Homes (MW)	4.93	48.03
Total Annual Commercial Solar PV Capacity Installed (all Buildings) (MW)	4.86	43.10
Total Annual Industrial Solar PV Capacity Installed (all Buildings) (MW)	1.76	11.92
Estimated Annual Total Solar PV Installed Under Policy by Year (MW)	17.09	143.92
Estimated Cumulative Total Solar PV Installed Under Policy by Year (MW)	33.54	850.27
Average full-capacity-equivalent hours of operation for Solar PV Systems:	2,355	2,355
*Based on data for Phoenix in table in guide document from Arizona Solar Center--See **Note 4**.*		
Implied New Solar PV Output, Cumulative Systems (GWh)	79	2,002
New Customer-sited Biomass/Landfill Gas/Biogas-fueled Capacity Per Year (MW)	5	10
Placeholder Assumptions		
Fraction of New Customer-sited Biomass/Landfill Gas/Biogas-fueled Capacity Fueled With:		
Landfill Gas	33%	33%
Biomass	33%	33%
Biogas	34%	34%
Placeholder Assumptions		
Average Full-capacity-equivalent Hours of Operation for Systems Above:	5,000	5,000
Placeholder Assumptions		
Implied Annual New Biomass/Landfill Gas/Biogas-fueled Capacity by Fuel (MW)		
Landfill Gas	1.65	3.30
Biomass	1.65	3.30
Biogas	1.70	3.40
Implied Cumulative New Biomass/Landfill Gas/Biogas-fueled Capacity by Fuel (MW)		
Landfill Gas	3.30	28.88
Biomass	3.30	28.88
Biogas	3.40	29.75
Implied Cumulative New Biomass/Landfill Gas/Biogas-fueled Electricity Output by Fuel (GWh)		
Landfill Gas	17	144
Biomass	17	144
Biogas	17	149
Average Net Heat Rate by Fuel (Btu Fuel Input/kWh Electricity Output)		
Landfill Gas	10,000	10,000
Biomass	12,000	12,000
Biogas	10,000	10,000
Placeholder Assumptions		

Implied Fuel Input by Fuel (Billion Btu)		
Landfill Gas	165	1,444
Biomass	198	1,733
Biogas	170	1,488

Inputs to Cost Estimates for Solar PV Systems (Data from Source in *Note 3*)

Capital Costs for PV Systems for New Homes		
Module	$ 3,345	$ 2,003
BOS (Balance of System)	$ 1,235	$ 739
Installation	$ 409	$ 143
Total System - $/kW	$ 4,989	$ 2,885
Total System - $	$ 9,978	$ 5,769

Capital Costs for PV Systems for Existing Homes		
Module	$ 3,749	$ 2,245
BOS (Balance of System)	$ 1,250	$ 748
Installation	$ 903	$ 315
Total System - $/kW	$ 5,902	$ 3,308
Total System - $	$ 17,706	$ 9,924

Commercial System Capital costs/kW Relative to New Residential *Rough assumption, but similar to values in literature--See* ***Note 6*** *.*	80%	80%
Solar PV Operating and Maintenance Costs ($/MWh) *Rough assumption--See* ***Note 7*** *.*	$ 5.88	$ 5.88
Federal Solar Tax Credits: Residential Sector--See ***Note 8***	0%	0%
Federal Solar Tax Credits: Commercial and Industrial Sectors--See ***Note 8***	10%	10%

Factors for Annualizing Capital Costs (Residential PV Systems)		
Interest Rate	7%	/yr
Economic Life of System	20	years
Implied Annualization Factor	9.44%	%/yr
Marginal Federal Tax Rate, Residential	28%	

Factors for Annualizing Capital Costs (Commercial and Industrial PV Systems)		
Interest Rate	8%	/yr
Economic Life of System	20	years
Implied Annualization Factor	10.19%	%/yr

Reduce Captial Costs for Solar Tax Credits and Federal Mortgage Deductions?	**YES**

Intermediate Results for Solar PV System Cost Estimates

Total Capital Costs for New Systems (thousand 2005 dollars) Net of Tax Credits		
Systems for New Residences	$ 27,618	$117,924
Systems for Existing Residences	$ 29,124	$158,867
Systems for Commercial/Industrial Installations	$ 23,783	$114,271
Annualized Capital Costs for All Systems (thousand 2005 dollars)		
Systems for New Residences	$ 3,844	$ 60,231
Systems for Existing Residences	$ 4,031	$ 76,115
Systems for Commercial/Industrial Installations	$ 4,920	$ 84,553
Annual Operating and Maintenance Costs for All Systems (thousand 2005 dollars)	$ 464	$ 11,764

Inputs to Cost Estimates for Biomass/Landfill Gas/Biogas-fueled Systems

Estimated Average Installed Capital Costs by System Type ($2005/kW)			
Landfill Gas	$ 2,000	$ 1,500	
Biomass	$ 2,500	$ 2,200	
Biogas	$ 2,500	$ 2,200	
Factors for Annualizing Capital Costs (all plant types)			
Interest Rate		8%	/yr
Economic Life of System		20	years
Implied Annualization Factor		10.19%	%/yr
Estimated Average Non-fuel Operating and Maintenance Costs by System Type ($/MWh)			
Landfill Gas	$ 20.00	$ 20.00	
Biomass	$ 20.00	$ 20.00	
Biogas	$ 20.00	$ 20.00	

Placeholder Assumptions

Intermediate Results for Biomass/Landfill Gas/Biogas-fueled Cost Estimates

Total Capital Costs for New Systems (thousand 2005 dollars)		
Landfill Gas	$ 3,300	$ 4,950
Biomass	$ 4,125	$ 7,260
Biogas	$ 4,250	$ 7,480
Annualized Capital Costs for All Systems (thousand 2005 dollars)		
Landfill Gas	$ 672	$ 5,096
Biomass	$ 840	$ 6,881
Biogas	$ 866	$ 7,090
Annual Non-Fuel Operating and Maintenance Costs for All Systems (thousand 2005 dollars)		
Landfill Gas	$ 155	$ 1,360
Biomass	$ 155	$ 1,360
Biogas	$ 160	$ 1,401
Total Non-Fuel Costs for All Systems (thousand 2005 dollars)		
Landfill Gas	$ 828	$ 6,456
Biomass	$ 996	$ 8,241
Biogas	$ 1,026	$ 8,491
Total Fuel Costs for All Systems (thousand 2005 dollars)		
Landfill Gas	$ 825	$ 7,219
Biomass	$ 495	$ 4,333
Biogas	$ 850	$ 7,438

Results	2010	2020	Units
Electricity			
TOTAL Reduction in Electricity Sales (electricity output from Solar PV and landfill gas/biomass/biogas systems)	129	2,440	GWh (sales)
Reduction in Generation Requirements	144	2,724	GWh (generation)
Gross GHG Emission Savings	**0.10**	**2.10**	$MMtCO_2e$
Landfill Gas			
Net Change in Gas Use (negative values denote increased use)	-165	-1,444	Billion BTU
Net GHG Emissions (negative values denote increased emissions)	0.00	-0.01	$MMtCO_2e$
Biomass			
Net Change in Biomass Use (negative values denote increased use)	-198	-1,733	Billion BTU
Net GHG Emissions (negative values denote increased emissions)	-0.001	-0.012	$MMtCO_2e$
Biogas			
Net Change in Gas Use (negative values denote increased use)	-170	-1,488	Billion BTU
Net GHG Emissions (negative values denote increased emissions)	0.00	-0.01	$MMtCO_2e$

Summary Results for RCI-7	2010	2020	Units
Total for Policy (All Fuels)			
Total Net GHG Emission Savings	**0.10**	**2.07**	$MMtCO_2e$
Net Present Value (2006-2020)		**$293**	$million
Cumulative Emissions Reductions (2006-2020)		9.6	$MMtCO_2e$
Cost-Effectiveness		**$30.62**	$/tCO_2e$

NOTES AND DATA FROM SOURCES

Note 1:

The Southwest Energy Efficiency Project's Report
Increasing Energy Efficiency in New Buildings in the Southwest: Energy Codes and Best Practices
includes state-by-state estimates of the potential savings from two scenarios of building code and "beyond code" efficiency improvements. For Arizona, the results of this work are summarized in a "State Fact Sheet", available as http://www.swenergy.org/ieenb/fact_sheet_arizona.pdf. Tables from this Fact Sheet are reproduced below, and are the source for the growth in housing and commercial building area used in this estimate.

Building Stock and Projected Growth

	Housing units 2000	Housing units 2020	Growth 2000-2020 (%)	Commercial area in 2000 ($ft^2 \times 10^6$)	Commercial area in 2020 ($ft^2 \times 10^6$)	Growth 2000-2020 (%))
AZ	2,189,189	3,315,965	51	1,183	2,287	93
Region	6,597,710	9,543,226	45	3,969	7,085	79
AZ as % of Region	33	35	-	30	32	-

Source: U.S. Census; Tellus Institute

Note 2:

Based on data in the 2003 Commercial Buildings Energy Consumption Survey Detailed Tables published by the US Department of Energy's Energy Information Administration, and available as http://www.eia.doe.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/pdf2003/allbc.pdf, the average floorspace per building for all commercial buildings in the Mountain West (including malls) was 13,313 square feet (calculated from data in Tables A5 and A6).

Note 3:

Source: Worksheet "Solar Homes Summary table.xls", with calculations in support of the California Million Solar Homes Initiative, authored by XENERGY, Inc., and provided by M. Lazarus.

Note 4:
Source: Arizona Consumer's Guide to Buying a Solar Electric System, From AZ Solar Center, http://www.azsolarcenter.com/design/azguide.pdf. See following Table.

Energy from the PV System (kWh/year)

Rated Capacity of PV system kW_p	Flagstaff	Phoenix	Tucson
0.5	1077	1177	1186
1.0	2155	2355	2372
2.0	4311	4708	4744
2.5	5385	5885	5930
3.0	6462	7062	7116
4.0	8622	9423	9488

- Determine the system's size in kilowatts (kW). A reasonable range is 1 to 5 kW. This value is the "kW_p of PV" input for the equations below.
- Based on your geographic location, determine the energy production from the table for the kWh/year.
- Divide this number by twelve if you want to determine your monthly energy reduction.
- Energy bills savings = (kWh/year) x (Residential Rate) = $/year saved
- (Residential Rate in this above equation should be in cents per kWh. For example, a 2-kW system in Tucson, at a residential energy rate of $0.08/kWh will save about $380 per year 4,744 kWh/kW-year x $0.08/kWh x 2 kW = $380/year).

Note 5:
Rough estimate of electricity consumption growth rates by Sector

Sector	Statewide Electricity Sales, 2004, MWh (USDOE EIA Data)	Estimated Sales by Sector 2010	2020
Residential	28,928	38,106	57,777
Commercial	25,632	32,153	45,267
Industrial	11,129	11,674	12,517
Total	65,688	81,933	115,561

Sector	Growth in Sales, 2004 to 2010	Annual Growth in Sales, 2010 to 2020	
Residential	4.70%	4.25%	Estimates based roughly on historical growth rates of electricity sales (1990-2002) by sector, adjusted downward to yield composite growth rate values equal to those agreed to by RCI TWG and CCAG (12/1/06 and 12/12/06)
Commercial	3.85%	3.48%	
Industrial	0.80%	0.70%	
Total	3.75%	3.50%	As agreed by RCI TWG and CCAG
Check on Total	3.75%	3.50%	

Note 6:
Source: International Energy Agency (IEA), TRENDS IN PHOTOVOLTAIC APPLICATIONS Survey report of selected IEA countries between 1992 and 2004. Report #IEA-PVPS T1-14:2005. Page 18.
"Indicative costs" in 2004 in USD per kWp (assumedly DC output) for on-grid PV systems in the US:

<10 kW	7000 to 10,000
>10 kW	6300 to 8500

In EIA Projections of Renewable Energy Costs, presented in "Forum on the Economic Impact Analysis of NJ's Proposed 20% RPS" by Chris Namovicz of the USDOE EIA (Energy Information Administration), dated February 22, 2005, and available as http://www.eia.doe.gov/oiaf/pdf/rec.pdf, a wind power average cost of

6000	dollars/kW is provided for a 25 kW Commercial system, or
8200	dollars/kW for a 2 kW Residential system, with

"Large potential for cost reduction".

Note 7:

An older (1997) US DOE document OVERVIEW OF PHOTOVOLTAIC TECHNOLOGIES
(available as http://www.eere.energy.gov/ba/pdfs/pv_overview.pdf) suggests that even early solar PV systems
had O&M costs of under $ 0.005 per kWh, which in 2005 dollars would be:
$ 0.0059 per kWh.

Note 8:

A description of the new Federal Solar Tax Credits for businesses and residences
as contained in the Energy Policy Act of 2005 (EPAct 2005) (see, for example,
http://www.seia.org/getpdf.php?iid=21) provides for 30% (of system cost) tax credits for solar PV investments by
businesses in 2006 and 2007, reverting to 10% thereafter. For residences, the credit in 2006 and 2007 is
30% with a "cap" of $2000, reverting to zero after 2007. For the purpose of this analysis, we are modeling
the federal tax credit at its long-term (10% business, 0% residential) level, as no systems
are added in 2006 and 2007.
See also, for Example,
http://www.sdenergy.org/uploads/PV-Federal%20Tax%20Credits%20Summary%206-01-04%20FINAL.pdf.

RCI-10 Demand-Side Fuel Switching

Date Last Modified: *4/17/2006 M. Lazarus*

Key Data and Assumptions	2010	2020/all	Units
First Year Results Accrue		**2007**	
a) Use of biofuels -- assumes use of blended fuels (could also look at use of neat fuels)			
For now this assessment is restricted to technical potentials based on simple assumptions			
Biodiesel			
Fraction of industrial diesel use substituted by biodiesel blend	**100%**	**100%**	
Fraction of commercial diesel use substituted by biodiesel blend	**100%**	**100%**	
This approach assumes that biofuels are supplied statewide as the standard filling station fuel. An alternative would be to consider "neat" (e.g. 100% or 85%) biofuel vehicles, with a smaller penetration rate above. If this state does not adopt biofuel standards then this would be the most relevant option. The numbers as presently shown would be equivalent to pure biodiesel being used in 2% (2010) and 20% (2020) of C/I applications.			
Lifecycle biodiesel emissions as a fraction of diesel emissions (tCO2e basis)		**22%**	
Biodiesel blend rate	**2%**	**20%**	by vol
This is a placeholder assumption, subject to TWG discussion. This implicitly assumes the state moves aggressively to use significant amounts of biofuel blend.			
Relative decrease in energy content	99.9%	98.6%	
Increase in blended fuel use (due to lowered energy content)	0.1%	1.4%	
Net decrease in diesel use per gallon biodiesel blend used	1.9%	18.6%	
Net decrease in tCO2e emissions per gallon replaced	**1.5%**	**14.6%**	
Ethanol			
Fraction of industrial gasoline use substituted by ethanol blend	**100%**	**100%**	
Fraction of commercial diesel use substituted by ethanol blend	**100%**	**100%**	
Corn: Lifecycle ethanol emissions as a fraction of diesel emissions		**79%**	tCO2e/MMBtu
Cellulosic: Lifecycle ethanol emissions as a fraction of diesel emissions		**21%**	tCO2e/MMBtu
Effects of Fuel Ethanol Use on Fuel-Cycle Energy and Greenhouse Gas Emissions," M. Wang, C. Saricks, and D. Santini, Argonne National Laboratory, January 1999. http://www.transportation.anl.gov/pdfs/TA/58.pdf.			
Target ethanol blend rate	**10%**	**10%**	by vol
This is a placeholder assumption, subject to TWG discussion. This implicitly assumes the state moves aggressively to use significant amounts of biofuel blend. (See above)			
Current ethanol blend rate	**3%**	**3%**	by vol
Need state average data here. This is merely a placeholder.			
Effective added ethanol	**7%**	**7%**	by vol
Relative change in energy content	97.8%	97.8%	
Increase in blended fuel use (due to lowered energy content)	2.2%	2.2%	
Net decrease in gasoline use (after accounting for energy content)	4.8%	4.8%	
Corn: Net decrease in tCO2e emissions per gallon replaced	**1.0%**	**1.0%**	
Cellulosic: Net decrease in tCO2e emissions per gallon replaced	**3.8%**	**3.8%**	
Corn ethanol as fraction of ethanol in blend	100%	80%	
Cellulosic ethanol as fraction of ethanol in blend	**0%**	**20%**	
This is a placeholder assumption, subject to TWG discussion.			